Professional Shop Manual

AC3 Series of 4-Cycle Engines

NOTE: These materials are for use by trained technicians who are experienced in the service and repair of outdoor power equipment of the kind described in this publication, and are not intended for use by untrained or inexperienced individuals. These materials are intended to provide supplemental information to assist the trained technician. Untrained or inexperienced individuals should seek the assistance of an experienced and trained professional. Read, understand, and follow all instructions and use common sense when working on power equipment. This includes the contents of the product's Operators Manual, supplied with the equipment. No liability can be accepted for any inaccuracies or omission in this publication, although care has been taken to make it as complete and accurate as possible at the time of publication. However, due to the variety of outdoor power equipment and continuing product changes that occur over time, updates will be made to these instructions from time to time. Therefore, it may be necessary to obtain the latest materials before servicing or repairing a product. The company reserves the right to make changes at any time to this publication without prior notice and without incurring an obligation to make such changes to previously published versions. Instructions, photographs and illustrations used in this publication are for reference use only and may not depict actual model and component parts.

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CHAPTER 1: INTRODUCTION

Professional Shop Manual intent

This Manual is intended to provide service dealers with an introduction to the mechanical aspects of the AC3 series of 4-cycle engines.

Disclaimer: The information contained in this manual is correct at the time of writing. Both the product and the information about the product are subject to change without notice.

About the text format:

NOTE: is used to point out information that is relevant to the procedure, but does not fit as a step in the procedure.

- Bullet points: indicate sub-steps or points.

⚠CAUTION	Caution is used to point out potential danger to the technician, operator, bystanders, or surrounding property.

⚠WARNING	Warning indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

⚠ DANGER	Danger indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations

Disclaimer: This manual is intended for use by trained, professional technicians.

- Common sense in operation and safety is assumed.
- In no event shall MTD be liable for poor text interpretation or poor execution of the procedures described in the text.
- If the person using this manual is uncomfortable with any procedures they encounter, they should seek the help of a qualified technician or MTD Technical Support.

Fasteners

- Most of the fasteners used on the engine are metric. Some are sized in fractional inches. For this reason, wrench sizes are frequently identified in the text, and measurements are given in U.S. and metric scales.
- If a fastener has a locking feature that has worn, replace the fastener or apply a small amount of releasable thread locking compound such as Loctite® 242 (blue).
- Some fasteners like cotter pins are single-use items that are not to be reused. Other fasteners such as lock washers, retaining rings, and internal cotter pins (hairpin clips) may be reused if the do not show signs of wear or damage. This manual leaves that decision to the judgement of the technician.

AC3 Series of engines

Assembly

Torque specifications may be noted in the text that covers assembly, they may also be summarized in tables along with special instructions regarding locking or lubrication. Whichever method is more appropriate will be used. In many cases, both will be used so that the manual is handy as a quick-reference guide as well as a step-by-step procedure guide that does not require the user to hunt for information.

The level of assembly instructions provided will be determined by the complexity and of reassembly, and by the potential for unsafe conditions to arise from mistakes made in assembly.

Some instructions may refer to other parts of the manual for subsidiary procedures. This avoids repeating the same procedure two or three times in the manual.

Description

The AC3 engine is used on a variety of handheld equipment. This engine has:

- 29cc's of displacement.
- A cantilever crank design.
- Pushrod activated OHV.
- Genuine 4-cycle design, not a hybrid 2-cycle/4-cycle like Stihl and Shindaiwa.
- Engine covers split front and back.

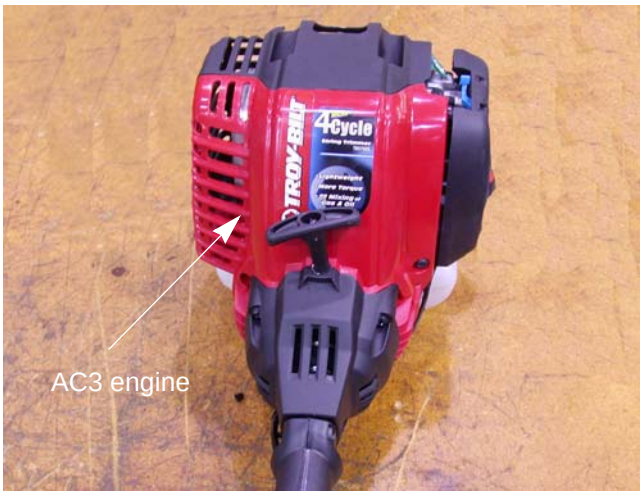

Figure 1.1

Currently there are engine models in this series of engine:

- AC3
- AC3.1
- AC3.2

The AC3 version has an 8 to 1 compression ratio. The AC3.1 and the AC3.2 have a 9 to 1 compression ratio which increased power approximately 20%. The AC3.1 and 3.2 engines are also available with electric start versions.

Identifying engines

AC2

- 26 cc's of displacement.
- Engine cover surrounds the cylinder head and muffler.

Visible from the rear:

- A plastic, diagonal split crankcase sump.
- A dip stick that threads into the sump.

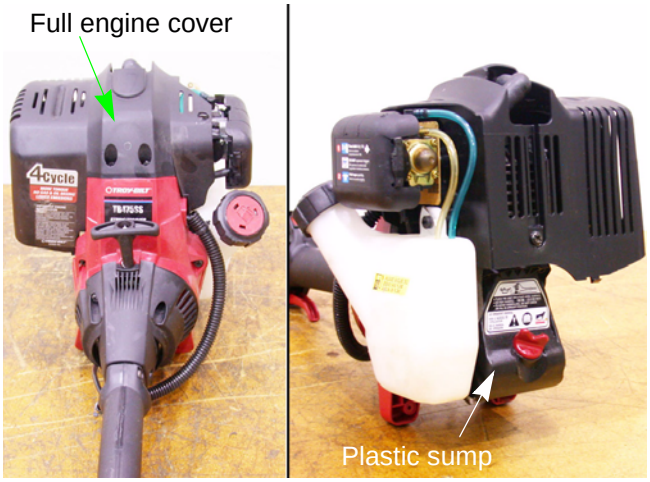

Figure 1.2

Figure 1.3

AC3

- 29cc's of displacement.
- Engine covers split front and back.
- Metal sump

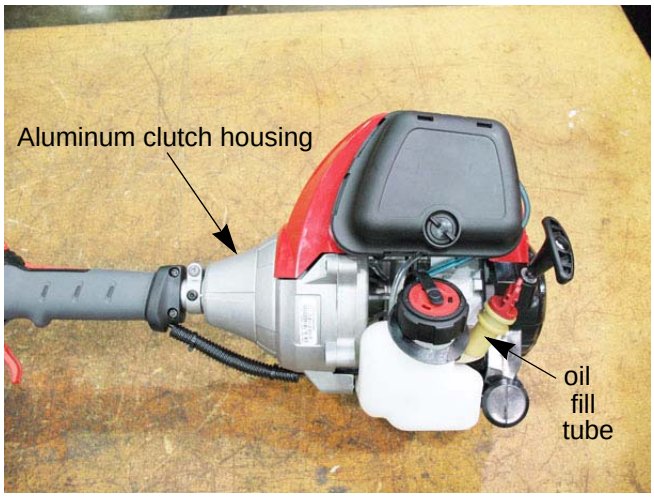

Figure 1.4

AC4

- 32 cc's of displacement.
- Aluminum clutch housing.
- Extended oil fill tube that is near the carburetor.
- End mounted recoil starter.

Figure 1.5

AC5

- 25 cc's of displacement.
- Identical to the AC4 except for the plastic clutch housing.

Model and Serial Numbers

The model (item) and serial number are on a little white sticker with bar code. These are the numbers needed when ordering parts. This sticker can be found on the side of the engine.

Figure 1.6

The model number is 41ADT59C711. The break down of what the number mean is as follows:

41 ..... Hand held product

.....A. ..... Sales level

..... D ..... Product type

.....T59 ..... Unique Identifier

.....C ..... Packaging code

.....711 ..... Customer number

The serial number is 1F296DZ0060. The serial number reads as follows:

1 ..... Engineering level

..F ..... Month of production (F = June)

.....29 ..... Day of the month

.....6 ..... Last digit of the year

.....D ..... Plant it was built in (MTD Southwest)

.....Z ..... Assembly line number

.....0060 ..... Number of unit built

CHAPTER 2: MAINTENANCE

MAINTENANCE

The information in this manual applies to the AC3 series of engines. Some basic principles may apply to engines produced by other manufacturers.

As the saying goes “an ounce of prevention is worth a pound of cure”. The same can be said about preventive maintenance on outdoor power equipment. By changing the spark plug, air filter, and oil at recommended intervals many failures can be avoided. Sometimes just clearing off yard debris that has collected through use can make the difference between a properly running piece of equipment and the expensive inconvenience of unplanned repairs.

Oil

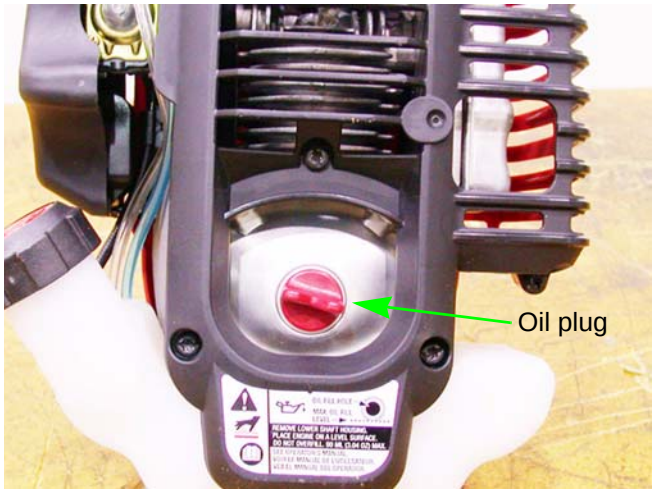

Figure 2.1

To check the oil:

1. Clean around the oil plug.
2. Place the trimmer on a level surface.
3. Unscrew the oil plug. See Figure 2.1.
4. The oil should be level with the bottom of the threads.

NOTE: If needed, add oil slowly until oil level is even with the bottom of the threads.

5. Tighten oil plug finger tight.

Changing the oil

The first oil change should be done at 10 hours and then it should be changed every 25 hours or at the start of the season.

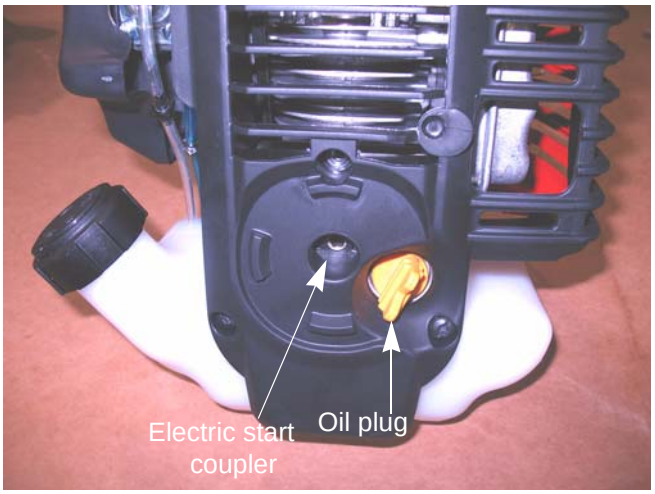

Figure 2.2

To change the oil:

1. Clean around the oil plug.
2. Remove the oil plug. See Figure 2.2.
3. Tip the trimmer to the side and drain the oil in a safe, approved container.
4. Disposed of the used oil by following the federal, state and local regulations.
5. Fill the engine with 3.04 fluid ounces (90 ml) of SAE 30 oil that meets or exceeds API SM standards.

NOTE: The spark arrestor should be cleaned and the valves adjusted at every oil change.

Spark plugs

The spark plug used in the 32cc trimmer is a Champion RDZ19H gapped to 0.025” (.655 mm).
See Figure 2.3.

Figure 2.3

Wear rate will vary with severity of use. If the edges of the center electrode are rounded-off, or any other apparent wear / damage occurs, replace the spark plug before operating failure (no start) occurs.

Cleaning the spark plug:

NOTE: We do not recommend cleaning spark plugs.

- Use of a wire brush may leave metal deposits on the insulator that causes the spark plug to short out and fail to spark.
- Use of abrasive blast for cleaning may cause damage to ceramic insulator or leave blast media in the recesses of the spark plug.
- When the media comes loose during engine operation, severe and non-warrantable engine damage may result.

Inspection of the spark plug can provide indications of the operating condition of the engine.

- Light tan colored deposits on insulator and electrodes is normal.
- Dry, black deposits on the insulator and electrodes indicate an over-rich fuel / air mixture (too much fuel or not enough air)
- Wet, black deposits on the insulator and electrodes indicate the presence of oil in the combustion chamber.
- Heat damaged (melted electrodes / cracked insulator / metal transfer deposits) may indicate detonation.
- A spark plug that is wet with fuel indicates that fuel is present in the combustion chamber, but it is not being ignited.

Spark plug removal and installation

To replace a spark plug:

1. Disconnect the spark plug wire. See Figure 2.4.

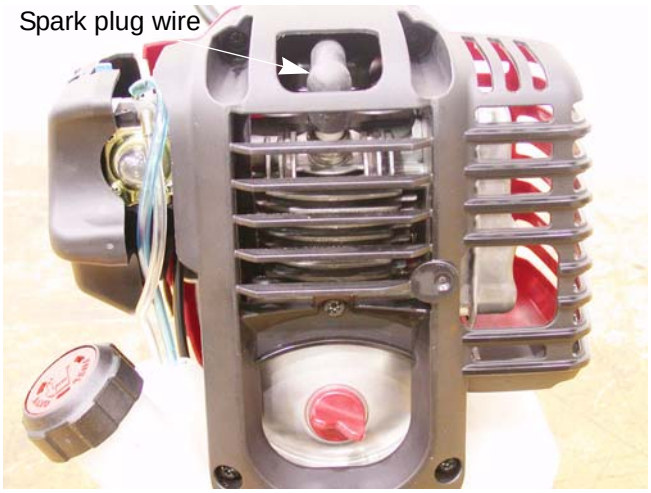

Figure 2.4

> **⚠CAUTION** Do not grab the spark plug wire with pliers. Damage to the spark-plug boot will result. A damaged spark plug boot will weaken the spark of the spark plug.

2. Remove the spark plug using a 5/8” spark plug socket.
3. Gap a new plug at 0.025” (.6 mm).
4. Install the spark plug and tighten to a torque of 100 - 110 in. lbs.(11 -12 Nm).
5. Follow steps 1 and 2 in reverse order.
6. Test run the trimmer in a safe area before returning it to service.

Air filter

A dirty air filter can reduce engine power, increase fuel consumption, increase CO emissions and make starting more difficult.

The air filter should be cleaned every 10 hours of use (depending on area of use, dusty areas require more frequent cleanings).

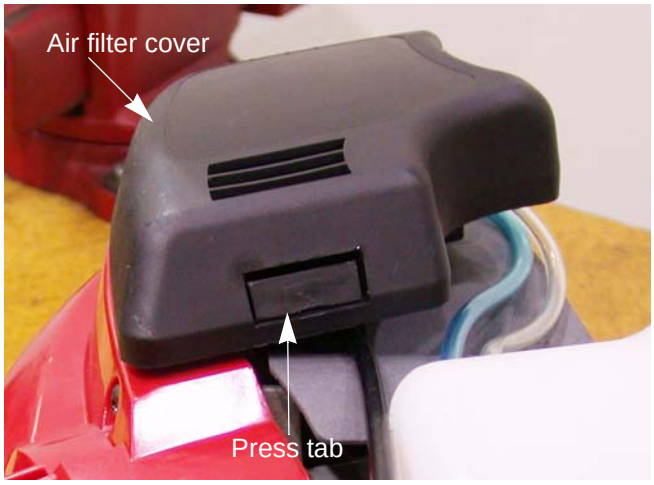

Figure 2.5

To clean/replace the air filter:

1. Remove the air filter cover by pressing in the tab on the bottom of the filter housing and lifting the cover off. See Figure 2.5.

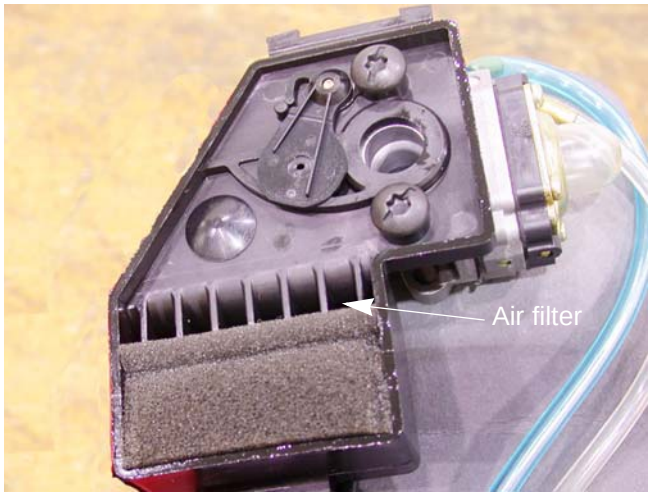

Figure 2.6

2. Pull the filter out. See Figure 2.6.
3. If the filter is crumbling or brittle, replace the filter.
4. Wash the air filter with warm soapy water. Let the filter air dry. **DO NOT** wring the filter out.

NOTE: Wringing the filter can tear it. Squeeze the filter, but do not twist it.

5. Put a 1/4 teaspoon (1.25cc) of oil to the filter and squeeze it through out the filter.
6. Insert the filter into air filter housing.
7. Install the air filter cover.
8. Test run the engine before returning it to service

Spark arrestor

The spark arrestor should be checked and/or cleaned every 25 hours of use.

NOTE: The spark arrestor also serves to keep blockages out of the exhaust system. Typical blockages include insect nests built during the dormant season.

NOTE: A spark arrestor is required by law when trimmer are used near “unimproved” land.

To check/clean the spark arrestor:

1. To clean the spark arrestor remove the engine cover using a T-20 driver. See Figure 2.7.

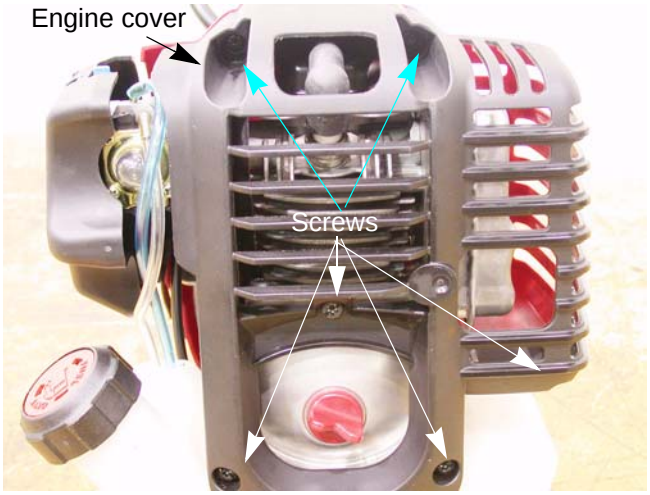

Figure 2.7

2. Remove the two screws holding the spark arrestor cover in place with a T-25 driver. See Figure 2.8.

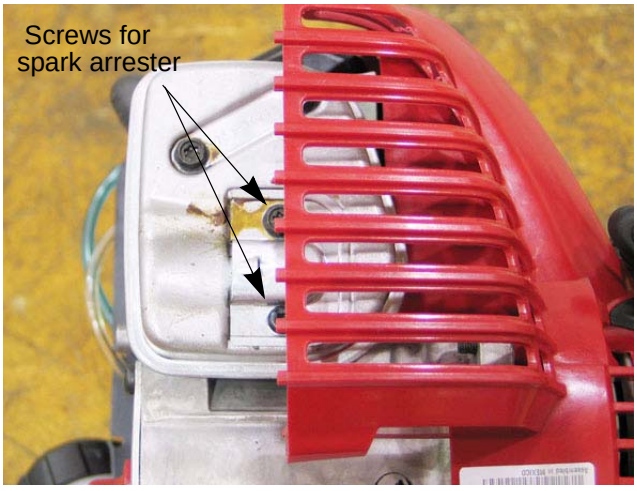

Figure 2.8

3. Inspect the spark arrestor. See Figure 2.9.
4. If it is blocked with carbon, remove it. It may be:
   - Replaced
   - Cleaned by mechanical means
   - Solvent cleaned
   - Burned clean using a butane or propane torch.
5. Reinstall the Spark arrestor screen By following the previous steps in reverse order.

   NOTE: Apply a thread locking compound such as Loctite® 266™ to the long bolt (the one with a hex head, it is the one closest to the other two hex head screws) and torque it to 50-55 in. lbs. (5.7-6.2 Nm). Hand tighten the short screw.

Figure 2.9

Fuel filer

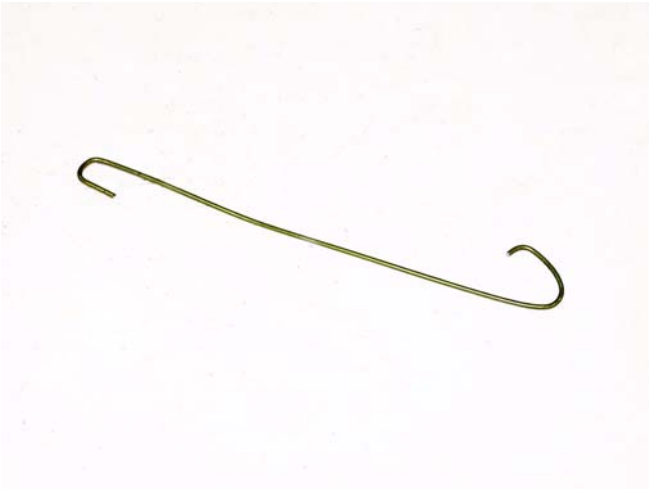

Figure 2.10

A dirty fuel filter can result in a lean run condition. The fuel filter should be replaced every 25 hours of use.

NOTE: The weighted fuel filter (clunk) keeps the filter submerged in the fuel at any angle of operation. The filter removes dirt and air bubbles from the fuel. Running the trimmer without the filter may allow air into the fuel line creating a lean run condition at higher RPMs. This will cause a catastrophic failure of the engine.

To replace the fuel filter:

1. Bend a piece of wire to make a hook. See Figure 2.10.
2. Remove the gas cap.

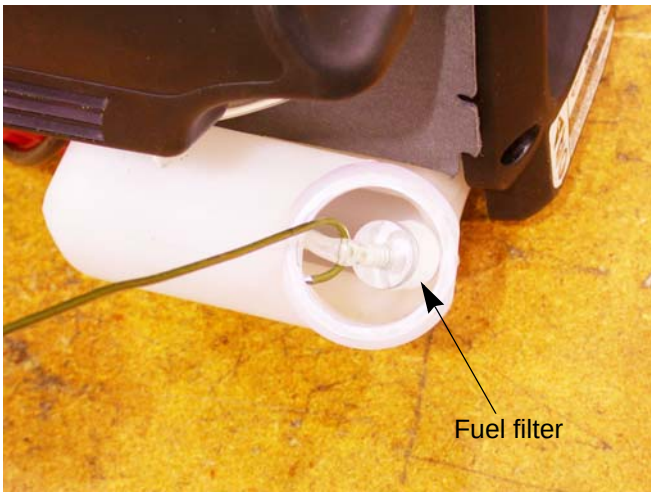

Figure 2.11

3. Stick the hook end of the wire into the fuel tank and fish out the fuel filter. See Figure 2.11.

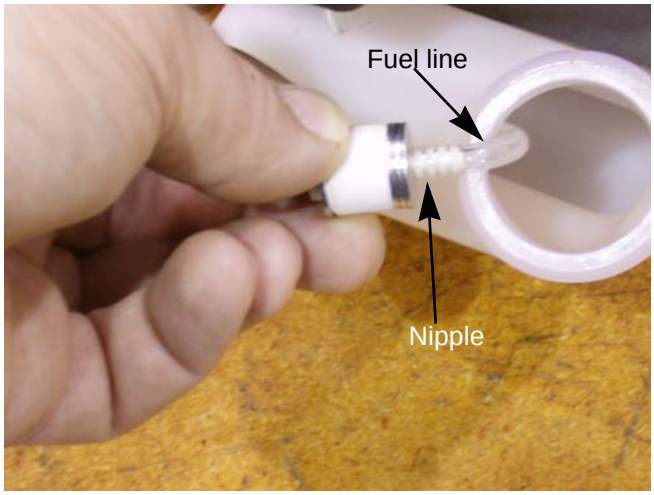

Figure 2.12

4. Carefully remove the fuel line from the barb on the fuel filter. Clean or discard the old fuel filter. See Figure 2.12.
5. Inspect the fuel lines. Replace them if they are cracked.
6. Install a new filter by following the previous steps in reverse order.
7. Test run the engine before returning it to service.

Valve lash

To adjust the valves:

NOTE: Loose valve lash on these engines can mimic the symptoms of a lean fuel/air mixture.

1. Remove the engine cover and spark plug, following the steps described in the previous sections of this chapter.
2. Remove the valve cover using a T-25 driver. See Figure 2.13.
3. Rotate the crankshaft to bring the piston to top dead center of the compression stroke (valves closed).

   NOTE: Use a probe in the spark plug hole to track the piston position.

   NOTE: The valve clearance for this engine is 0.003”-.006”(.08-.15 mm) for both valves.

Figure 2.13

4. Check the valve lash by inserting a feeler gauge between the rocker arm and the valve stem. To adjust the valve, loosen or tighten the fulcrum nut with a 8mm wrench until there is a slight drag on the feeler gauge. See Figure 2.14.
5. Inspect the valve cover gasket for damage. If it is damaged or compressed, replace it.
6. Reassemble the trimmer by following steps 1 and 2 in reverse order.
7. Test run the engine in a safe area before returning it to service.

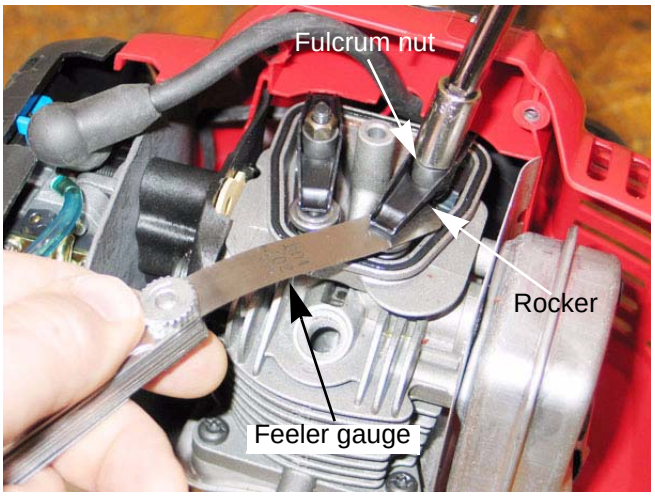

Figure 2.14

CHAPTER 3: TROUBLESHOOTING

Definitions

Troubleshooting - The act of gathering information by preforming tests and direct observations.

Diagnosis - A theory of what the problem is, based on the information gathered by troubleshooting.

Introduction

Diagnosing an engine is an art form that is built on several factors. First and most importantly is a good understanding of how the engine works. The second is a skill set that has been honed by experience. Finally the use of visual observations and a structured, systematic approach to troubleshooting a problem.

The first part of this chapter will outline the steps of troubleshooting an engine so a technician can form a proper diagnosis. The second half of this chapter will describe specific procedures and tests to preform while troubleshooting.

⚠CAUTION The first two rules in troubleshooting are to cause no further harm to the engine and to prevent injuries. Always check the oil level and condition before starting an engine. Check attachments for damage and make sure they are firmly mounted.

Steps to troubleshooting

NOTE: The steps and the order of the steps that follow are a suggested approach to troubleshooting the trimmer engine. The technician does not necessarily have to follow them as described in this chapter

Define the problem

The first step in troubleshooting is to define the problem:

1. Crankshaft will not turn.
    - Hard to pull rope, steady pressure
    - Rope jerks back
    - Rope will not pull at all
2. Crankshaft turns, no start
3. Starts, runs poorly
    - Starts, then dies
    - Runs with low power out put
    - Makes unusual smoke when running
        I. Black smoke, usually heavy
        II. White smoke, usually heavy
        III. Blue smoke. usually light
    - Makes unusual sounds when running
        I. Knock
        II. Click
        III. Chirp
        IV. Unusual exhaust tone

There are tools that the technician can use in order to define the problem, such as:

1. Interview the customer.
   - Get a good description of their complaint.
   - If it is an intermittent problem, verify what conditions aggravates the problem as best as possible.
   - Get an accurate service history of the equipment.
   - Find out how the customer uses and stores the equipment.
2. Direct observation:
   - Do not take it that the customer is correct with their description of the problem. Try to duplicate the problem.
   - Check the general condition of the equipment (visually).
     I. Cleanliness of the equipment will indicate the level of care the equipment has received.
     II. Make sure the engine and attachments are securely fastened.
     III. The tune-up factors.

   NOTE: Most hard starting and poor running conditions can be solved by preforming a tune-up.

   a. Check the condition and amount of oil in the crankcase.
   b. Check the level and condition of the fuel.
   c. Check the air filter and look for signs of dirt ingestion.
   d. Check the ignition and “read” the spark plug.
   e. Look for obvious signs of physical damage, bent blade, exhaust system blockage or cooling system blockage.

6. Broken starter rope.
   - Usually means the engine was hard to start.
   - Makes it impossible to confirm any running or hard starting symptoms by direct observation.
   - Some inference can be made from checking other factors of the general condition of the equipment.

Identify factors that could cause the problem

This is the second step in the troubleshooting process.

1. Crankshaft will not turn.

- Hard to pull rope, steady pressure - This usually indicates a mechanical bind of some sort. the likely suspects are:

  II. A parasitic load from a jammed attachment or drive shaft.

  III. An internal drag from a scored or seized piston.

- Rope jerks back - This usually indicates that the piston is stopping before top dead center on the compression stroke and is being driven back down by compression or combustion. The likely suspects are:

  I. Compression that is unusually high.

  a. valve lash.

  b. a partial hydraulic lock.

  III. Ignition timing is advanced.

  a. Improper air gap.

  b. Sheared or missing flywheel key.

  c. The wrong flywheel or module is installed on the engine.

- Rope will not pull at all -This is usually either a quick fix or a catastrophic failure. The likely suspects are:

  I. A broken starter recoil (easy fix).

  II. Complete hydraulic lock (easy fix).

  III. External binding/jammed attachment (easy fix).

  IV. Internal binding, crankshaft, connecting rod or piston (unrepairable)

5. Crankshaft turns, no start.

- Most gasoline engine diagnosis involves isolating problems in the four critical factors an engine needs to run properly:

  I. Ignition- sufficient spark to start combustion in the cylinder, occurring at the proper time.

  II. Compression- enough pressure in the cylinder to convert combustion into kinetic motion. It also needs sufficient sealing to generate the vacuum needed to draw in and atomize the next intake charge.

  III. Fuel- correct type and grade of fresh gasoline; in sufficient quantity, atomized (tiny droplets) and in correct fuel/air proportions.

  IV. Flow- if all of the above conditions are met, but the flow of air is constricted on the inlet or exhaust side it will cause the engine to run poorly or not at all. This also includes ensuring the valves are timed to open at the proper time.

- Isolate the ignition system and compression from the fuel system by preforming a prime test.

  I. Burns prime and dies. This would indicate a fuel system issue.

  II. Does not burn prime. Not a fuel system issue. Check for an ignition, compression or flow problem.

- Compression or ignition problem
    I. Check the engine stop and/or ignition switch.
    II. Test the ignition system using a proper tester.
    III. Replace the spark plug with a new one or a known good one.
    IV. Check compression.
    V. Check valve lash.
    VI. Check valve timing/actuation.
    VII. Check exhaust.

8. Starts, runs poorly

- Starts, then dies
    I. Run the engine with a spark tester in-line between the spark plug wire and the spark plug or use an oscilloscope and see if the spark goes away at the same time the engine dies.
    II. Check choke operation.
        a. Black smoke?
        b. Wet plug?
    III. Test for invisible damage to the air filter by starting the engine with the air filter removed.
    IV. Prime test immediately after engine dies. If it restarts; this may indicate a problem with fuel flow to the carburetor. Check the gas cap, fuel line, fuel filter, and the carburetor.
- Runs with low power output.
    I. Look for unusual exhaust color (smoke).
    II. Unusually hot muffler (may glow red).
        a. Retarded ignition
        b. Exhaust valve opening early (lash too tight)
    III. Mechanical bind
        a. A loose ignition module can drag on the flywheel or lock it up.
        b. Parasitic external load. A bind in the equipment the engine is powering.
        c. Internal drag from a scored piston or similar damage.
    IV. Low compression
        a. Check valve lash
        b. Check compression
    III. Flow blockage
        a. Exhaust blockage, usually accompanied by an unusual exhaust sound.

NOTE: Just as a throttle on the carburetor controls the engine RPMs by limiting the amount of air an engine can breathe in, an exhaust blockage will limit engine performance by constricting the other end of the system.

II. The muffler itself my be blocked.

III. The spark arrestor may be blocked.

IV. The exhaust valve may not be opening fully, possibly because of extremely loose valve lash settings.

V. The exhaust valve seat may have come loose in the cylinder head. This may cause a loss of compression, a flow blockage or it may randomly alternate between the two.

NOTE: The cause of an exhaust valve seat coming loose is usually over-heating.

VI. Intake blockage

a. An intake blockage up-stream of the carburetor will cause a rich fuel/air mixture and constrict the amount of air that the engine can draw in, limiting performance. A blocked air filter is a common cause of this.

b. An intake valve that does not open fully will cause a blockage. A possible cause of this is loose valve lash.

VII. Makes unusual smoke when running

a. Black smoke, usually heavy usually indicates a rich air fuel mixture

- Not enough air: air filter blockage or a partially closed choke.
- Too much fuel: needle valve stuck or metering / emulsion issues with the carburetor.

b. White smoke, usually heavy

- Oil in muffler, usually the result of improper tipping. the engine will “fog” for a minute or so, then clear-up on its own.
- Oil that is diluted with gasoline. It may be caused by improper tipping. It can also be caused by leaky carburetor needle valve, if there is a down-hill path from the carburetor to the intake port. Check oil for gasoline smell, repair carburetor.

c. Blue smoke, usually light.

VIII. PCV system

a. May be blocked or unplugged.

b. May be over-come by massive over-filling or oil dilution with gasoline.

c. Will cause oil to exit the engine via any low-resistance paths.

IX. Piston rings

a. Confirm with leak-down test.

b. Smoke will be more pronounced under load.

c. Repair may not make economic sense.

X. Valve guides (and intake valve stem seal).

a. Smoke will be more pronounced on over-run.

b. Makes unusual noise when running.

- Knock
  - Check for loose mounting of engine or driven implement
  - Rotate crankshaft back-and-forth to check for loose connecting rod.
- Click
  - Half-engine speed clatter: loose valve lash.
  - Half-engine speed clatter, slightly heavier: wrist-pin.
  - Rhythmic heavy-light engine speed click: piston slap
- Spark-knock
  - Advanced ignition timing
  - Low octane fuel
  - Over-heating engine (check for blocked cooling air flow)
  - Carbon build-up in cylinder: glowing carbon chunks pre-igniting air fuel mix.

XI. Unusual exhaust tone

a. Splashy, blatty, wheezing or whistling.

- Splashy or blatty idle usually indicates a slightly rich condition.
- Whistling or wheezing may indicate an exhaust blockage, usually slightly muffled.
- Backfire
  - On over-run: unburned fuel igniting past exhaust valve. Mixture not burning completely in combustion chamber. It may be too rich or it may be a spark plug or an ignition problem.
- Skip
  - Usually ignition related.
  - Run the engine with a spark tester in-line between the spark plug wire and the spark plug or use an oscilloscope and see if the spark goes away at the same time the engine dies.

XII. Engine RPMs surge (hunting)

a. Lean Air-fuel mixture condition- When AFR (Air Fuel Ratio) is significantly below stoichiometric ratio (14.7:1) engine RPMs sink until they reach a point that can be supported by the available fuel. This causes a momentary surge in power until the available fuel is consumed, then the RPMs fall again, repeating the cycle.

- Too much air: look for an air leak in the intake tract
- Not enough fuel: look for fuel supply or carburetor problems

Repairing the problem

The third step in the diagnostic process is to repair the problem. This step consists of:

1. Form a diagnosis by using all of the information gathered from the troubleshooting that was performed.
2. Physically perform the repair.

The fourth, and hopefully final, step in the troubleshooting process is the follow through. This step consists of:

1. Thoroughly test the repaired equipment: confirming that the initial diagnosis was correct. If it was wrong, start the troubleshooting process over again.

   NOTE: Sometimes the engine will have multiple problems at the same time. By performing one repair, other issues may show up that are unrelated to the first repair.

2. Delivery to customer: We are not just repairing equipment, we are repairing customers.

   - Inoculate against recurring problem with education, e.g.... if the problem was caused by stale fuel, make sure the customer is aware that fuel goes bad over time.
   - Make sure the customer understands the repair, preventing “superstitious” come-backs.

Diagnostic tests

When troubleshooting an engine, the diagnostic tests are done in a specific order. The order is:

1. Compression testing
2. Ignition testing
3. Carburetor/fuel system testing.

   NOTE: A prime test is a handy short cut. It will test compression and ignition in a single step. If the engine will start from a prime test, the problem is in the fuel system. If the engine will not start with the prime, the compression and ignition tests will need to be performed.

Prime test

To perform a prime test:

1. Prime the engine through the carburetor throat using a squirt bottle, filled with clean fresh gasoline.

   NOTE: Inspect the air filter while priming the engine. Look for a dirty or plugged filter that could prevent air flow or a missing filter that would indicate dirt ingestion.

2. Make sure the ignition switch is in the run position.
3. Attempt to start the engine.
4. If the engine starts and runs long enough to burn the prime, the problem is effectively isolated to the fuel system. proceed to Chapter 5: The Fuel System and Carburetor.
5. Check ignition system as described in Chapter 4: Ignition.
6. Testing compression:

Compression testing

To perform a compression test:

NOTE: If the engine will run, start the engine and let it warm up first for a better reading.

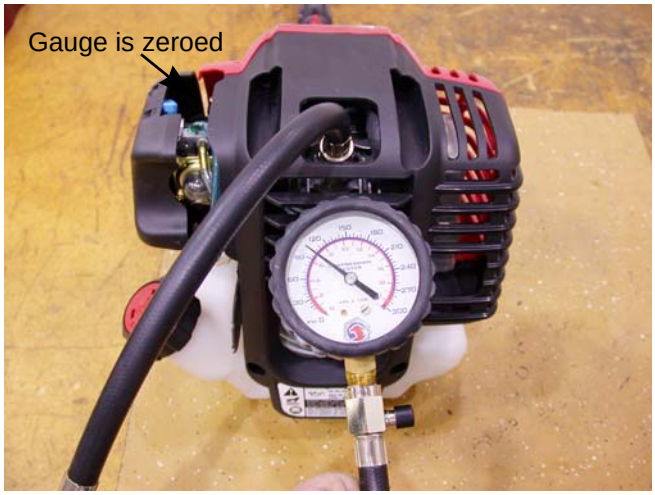

Figure 3.1

1. Disconnect the high-tension lead from the spark plug and ground it well away from the spark plug hole.
2. Remove the spark plug using a 5/8” spark plug socket.
3. Pull the starter rope several times to purge any fuel or oil from the combustion chamber.

NOTE: Air compresses readily, liquid does not. Liquid in the combustion chamber will result in an artificially high compression reading.

4. Install a compression gauge in the spark plug hole.
5. Confirm that the gauge is “zeroed”, then pull the starter rope repeatedly, until the needle on the gauge stops rising. See Figure 3.1.
6. Read the gauge.

NOTE: Most good quality compression gauge sets come with a 10mm adapter is needed to thread into the spark plug hole. If an adapter is needed, a Matco service part # CT606 or a Mityvac 05505 Compression Tester Spark Plug Adapter can be used with most gauges.

NOTE: When checking compression on small displacement engines, use a compression gauge set with the shortest available (or no) hose.

Interpreting compression readings:

Readings in psi	Possible causes
<20 (1.4 Bar)	Most likely a stuck valve or too tight of a valve lash, provided the starter rope pulls with normal effort.
20-90 (1.4 - 3 Bar)	Valve seat damage or piston ring and/or cylinder wear.
90 - 125 (6.2 - 8.6 Bar)	Normal readings
>125 (>8.6 Bar)	Excessive valve lash, a partial hydraulic lock, a bad cam or a bad automatic compression relief.

CHAPTER 4: IGNITION

Troubleshooting the Ignition System

The purpose of the ignition system is to provide a spark in the combustion chamber at the proper time to ignite the fuel/air mixture.

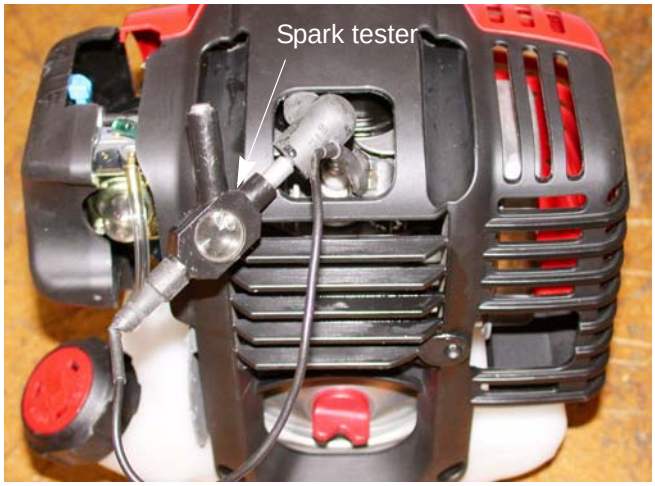

Figure 4.1

To troubleshoot the ignition system:

1. Examine the spark plug by following the steps described in the spark plug section of this chapter.
2. After examining the spark plug, reinstall it, or a new one to ensure a good spark plug is being used.
3. Disconnect the spark plug wire.
4. Connect a spark tester to the spark plug wire.
5. Connect the other end of the spark tester to the engine block. See Figure 4.1.

⚠CAUTION Never remove the spark plug and hold it against the engine block to test for spark. The fuel/air mix coming out of the spark plug hole will catch on fire.

NOTE: It only takes 1,000 volts to jump a 0.025” air gap in open atmosphere, it takes 10,000 volts to jump the same gap at 120 psi, therefore an open air spark test in not valid.

NOTE: The spark should be a minimum of 10 Kv (10,000 volts) at pull over speed.

6. Make sure the engine stop switch is in the “RUN” position.

NOTE: Most stop switches used on MTD handheld products are spring loaded to the “RUN” position when it is released. This prevents no-start situations caused by the customer failing to turn the switch on.

NOTE: Once the engine stop switch is moved to the “OFF” position, it sends a ground signal to the module. The circuitry in the ignition module will latch the primary winding to ground until the engine stops. This prevents the need to hold the switch in the “OFF” position until the engine comes to a complete stop.

7. Rapidly rotate the engine while watching the spark tester for sparks.
8. If no sparks are seen in the spark tester, test the module.

Testing the module

To test the module:

1. Remove the starter housing by following the procedures described in Chapter 6: Starter.
2. Check the air gap for the module. Set it to 0.010” by following the steps described in the module section of this chapter.
3. Disconnect the red wire. See Figure 4.2.
4. Install the starter as described in the starter section of this chapter.
5. Install the clutch as described in the clutch section of this chapter.
6. Pull the starter rope with the spark tester still hooked up to the spark plug wire.
   - If there is spark now, test the engine stop switch and check the red wire for a short to ground.
   - If there still in no spark, hold a screwdriver against the magnets on the flywheel to feel if they are magnetic. If the magnets are good, replace the module. If not, replace the flywheel.

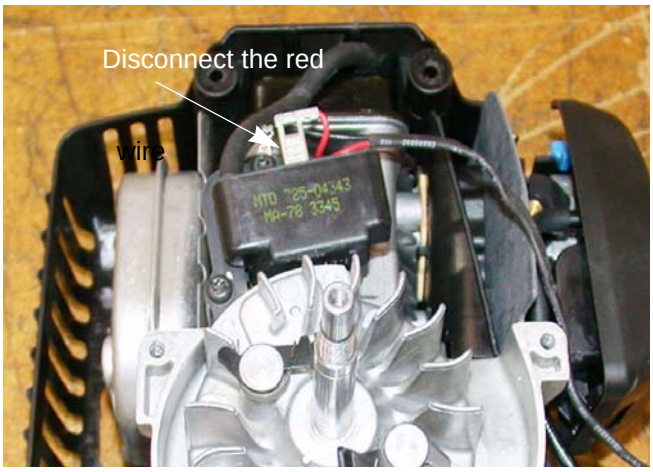

Figure 4.2

Test the engine stop switch

Figure 4.3

To test the engine stop switch:

1. Open the grip by removing the five screws with a T-20 torx driver.
2. Disconnect the wires from the engine stop switch.
3. Connect an ohm meter or continuity light to the switch.
4. With the switch in the engine run position (I), the meter should indicate no continuity. See Figure 4.3.

NOTE: Most stop switches are spring loaded to the run position when it is released. This prevents no-start situations caused by the customer failing to turn the switch on.

Figure 4.4

5. Hold the switch in the stop position (0). The meter should indicate continuity. See Figure 4.4.
   - If the results are not as described, the switch is bad and should be replaced.
   - If the switch is working properly, there is a short in the wires.

NOTE: If there is reason to suspect that the ignition timing is off:

- Remove the starter by following the steps described in Chapter 6: Starter.
- Make sure the module air gap is correct by following the steps described in the module section of this chapter.
- Inspect the flywheel. If the flywheel is damaged, replace the flywheel.
- Remove the flywheel by following the steps in the flywheel section of this chapter.
- Inspect the flywheel key, if damaged replace the key.
- Inspect the key way on the crank shaft for damage, if damaged short block the engine.

6. Assemble and test run the engine before returning it to service.

Module

Remove the ignition module:

1. Remove the starter by following the procedures described in Chapter 6: starter.
2. Disconnect the two wires from the module. See Figure 4.5.

   NOTE: The black wire will come off with the module mounting screws.
3. Remove the module by removing the two screws.

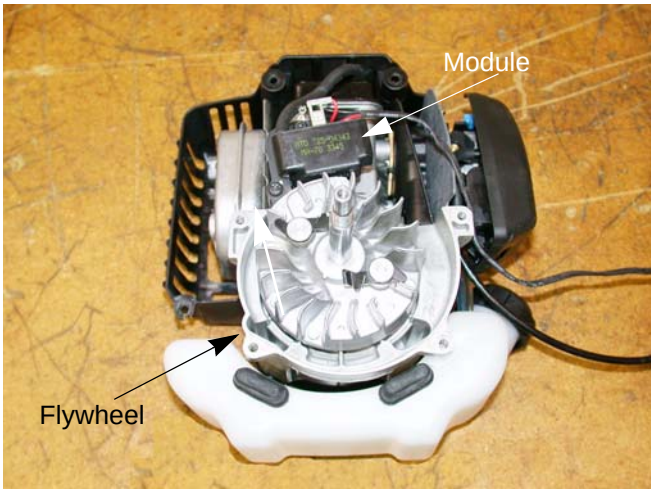

Figure 4.5

4. To install the module, turn the flywheel so that the magnets are away from the module.
5. Install the two screws half way. Do not tighten them down.

   NOTE: Make sure the black wire is on the proper mounting screw. See Figure 4.6.
6. Place a non-magnetic, 0.010” feeler gauge on the flywheel magnets and rotate the flywheel until the magnets line up with the module. Let the magnets draw the module against the flywheel with the feeler gauge trapped between them. See Figure 4.6.

   NOTE: The air gap range is 0.010” - 0.015” (0.25 - 0.38mm).

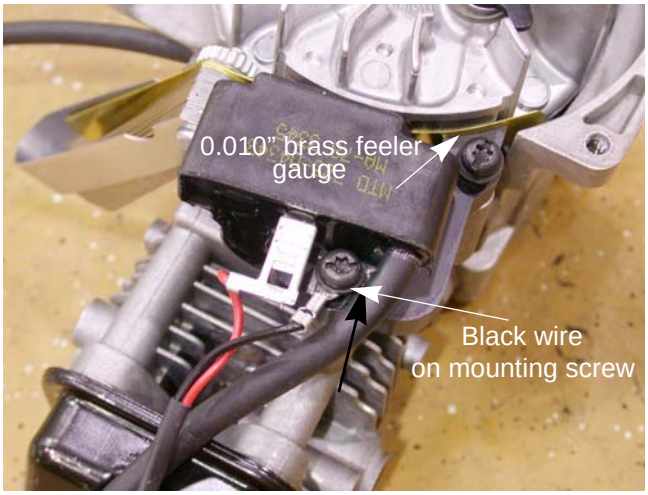

Figure 4.6

7. Torque the module screws to 28 - 35 in lbs (3 - 4 Nm).
8. Reassemble the engine by following the above steps in reverse order.
9. Test run the engine in a safe area before returning it to service.

Flywheel

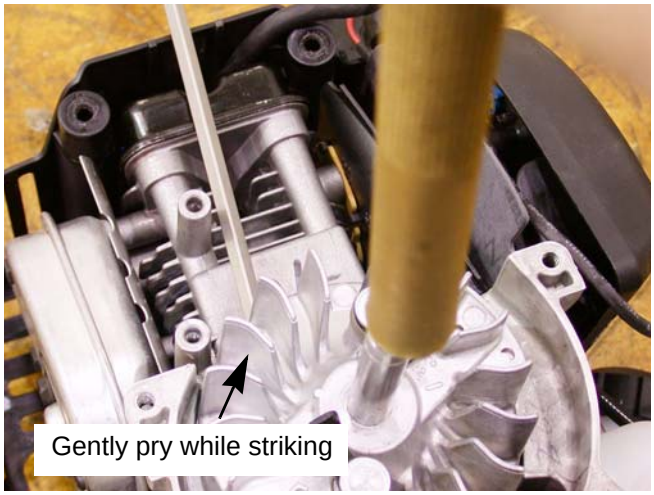

Figure 4.7

To remove the flywheel:

1. Remove the spark plug by following the steps described in Chapter 2: Maintenance.
2. Remove the starter by following the procedures described in Chapter 6: starter.
3. Remove the flywheel by striking the crankshaft with a brass punch. See Figure 4.7.

NOTE: It is not necessary to remove the module to remove the flywheel.

4. Inspect the flywheel and key for any signs of damage.
5. Install the flywheel by following the previous steps in reverse order.

NOTE: Tighten the clutch to a torque of 100 - 150 in lbs (11 - 17 Nm).

NOTE: Set the module air gap by following the steps described in the previous section of this manual.

6. Test run the engine before returning it to service.

CHAPTER 5: FUEL SYSTEM AND CARBURETOR

The function of the fuel system is to store fuel, mix the fuel with air and deliver it to the combustion chamber. The fuel system consists of the following components:

- Fuel tank
- Fuel lines
- Fuel filter
- Carburetor

NOTE: When working on the fuel systems, look at the whole system. A problem will rarely be isolated to one component.

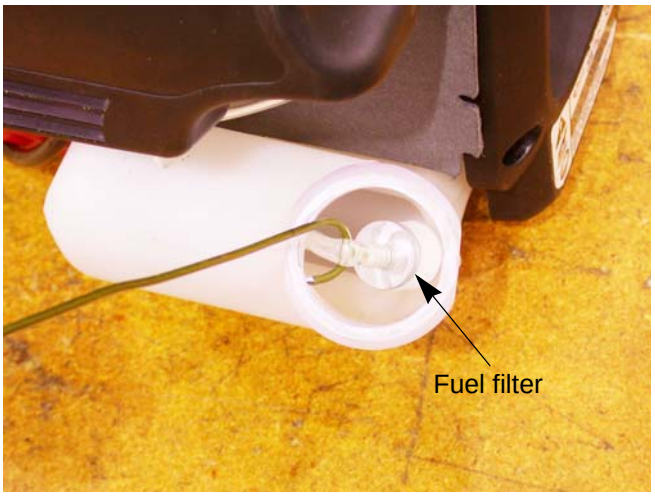

Figure 5.1

To troubleshooting the fuel system:

1. Drain and inspect the fuel by following the steps described in the next section of this chapter.
2. Inspect the fuel filter. If it is dirty, replace it following the steps described in Chapter 2: Maintenance. See Figure 5.1.
3. Inspect the fuel lines:
   - 3a. Are they cracked?
   - 3b. Are they clogged?
   - 3c. Are they brittle?

NOTE: If the answer to any of the above is yes, replace the fuel lines following the procedure described in the fuel line section of this chapter.

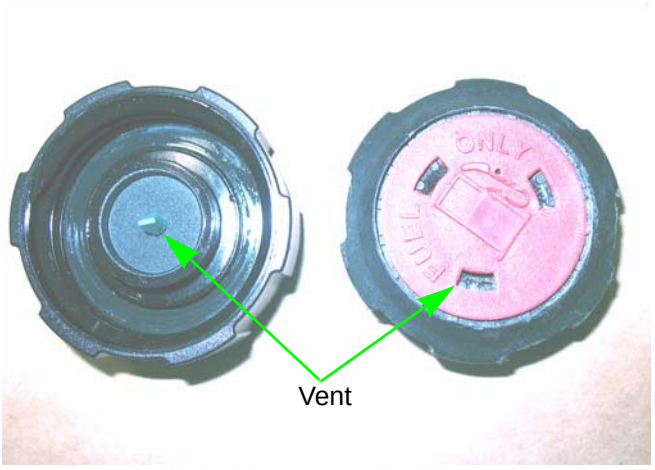

Figure 5.2

4. The fuel cap is vented. Ensure that the vent is clean and working properly. See Figure 5.2.
5. Test and inspect the primer bulb:
   - 5a. Is it leaking or is it brittle?
   - 5b. If so, replace the primer bulb.
   - 5c. Does it circulate fuel when pumped?
   - 5d. If not, replace the primer.
6. If compression, ignition and fuel supply are OK, but the engine does not run with fresh fuel, repair or replace the carburetor as described in the Carburetor Repair section of this chapter.
7. Test run the engine before returning it to service.

Inspecting the fuel:

NOTE: Fuel is the maintenance item most often overlooked by consumers. A lot of fuel system problems are caused by bad gasoline. When inspecting the fuel:

- Look for water.
- Look for dirt.
- Look for discoloration.
- Sniff carefully to see if it smells like varnish or kerosene.
- Save the fuel to show to customer.
- Look for oil in the fuel.
- Test the fuel for alcohol content.

NOTE: Save a sample of the fuel collected to show the customer.

NOTE: Customers pouring engine oil into the fuel tank seems to be a growing problem.

Test fuel for alcohol:

Fuels currently on the market contain a wide array of additives. Some of these additives oxygenate the fuel. Oxygenated fuel reduces emissions, and is required in some parts of the United States. Fuel make-up varies seasonally and geographically. Ethanol is the primary additive used to oxygenate fuel.

Ethanol in fuel creates a lot of problems for gasoline engines. The biggest problem is that alcohol attracts and holds water. This corrodes the metal components of the fuel system, especially the carburetor. Alcohol also does not produce as much heat as gasoline when burnt. This results in less power for the engine.

The ideal fuel/air mixture ratio (stoichiometric ratio) for an engine burning alcohol is much richer than the stoichiometric ratio an engine running on gasoline. An engine tuned to run on gasoline will not run well on alcohol. The more alcohol there is in the fuel beyond the 10% that is anticipated, the further the fuel/air mixture will be from the correct ratio.

A 10% ethanol (E10) mix is acceptable for MTD engines. Anything higher than that will result in performance issues.

NOTE: E20 and E85 fuels are not to be used in any MTD engines.

There are several alcohol test kit available commercially. See Figure 5.3.

Figure 5.3

Figure 5.4

Generally these kits involve mixing a measured amount of water and gas together and seeing were the boundary layer is. See Figure 5.4.

The test kit should come with a chart to compare the boundary layer height to alcohol percentage.

Fuel tank

To remove/replace the fuel tank:

1. Remove the air filter cover.
2. Disconnect the fuel lines from the carburetor. See Figure 5.5.

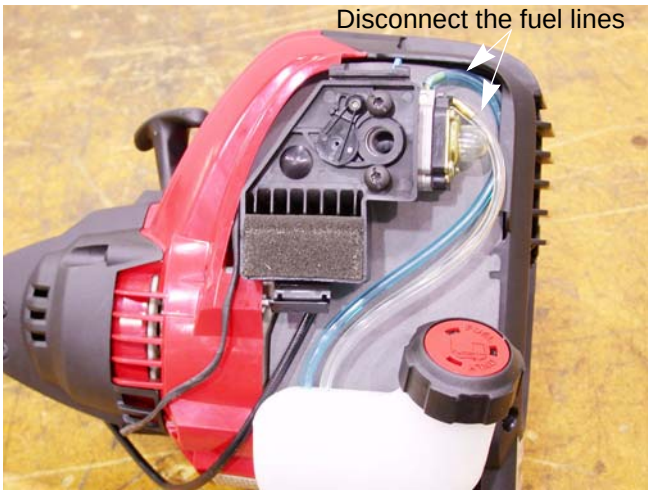

Figure 5.5

3. Remove the engine cover by removing the six screws that hold it in place. See Figure 5.6.
4. The fuel tank will slide out to the rear.

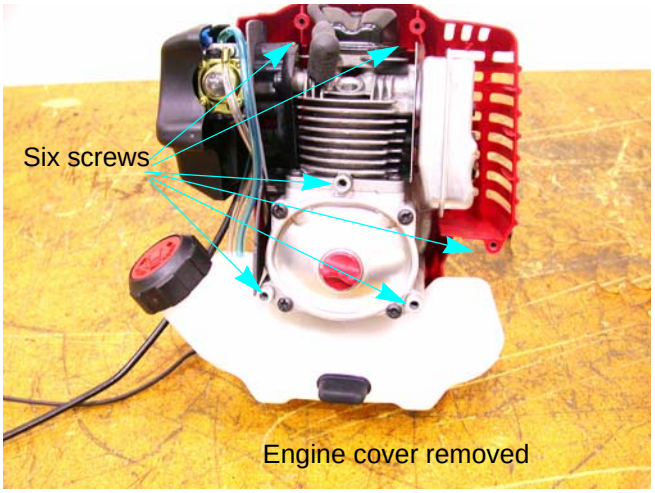

Figure 5.6

To install the fuel tank:

NOTE: Make sure the insulators are on the fuel tank.

NOTE: The fuel lines are part of the fuel tank. See Figure 5.7.

5. Insert the two tabs into the two slots in the starter housing.
   - Connect the fuel lines to the carburetor. The blue line is the return line and the clear line is the supply line.
   - Align the third tab on the fuel tank with the slot in the engine cover. Position the engine cover and secure.

   NOTE: The three plastic thread screws go into the starter housing and the three machine threaded screws go into the engine block.
6. Install the engine cover.
7. Test run the trimmer before returning it to service.

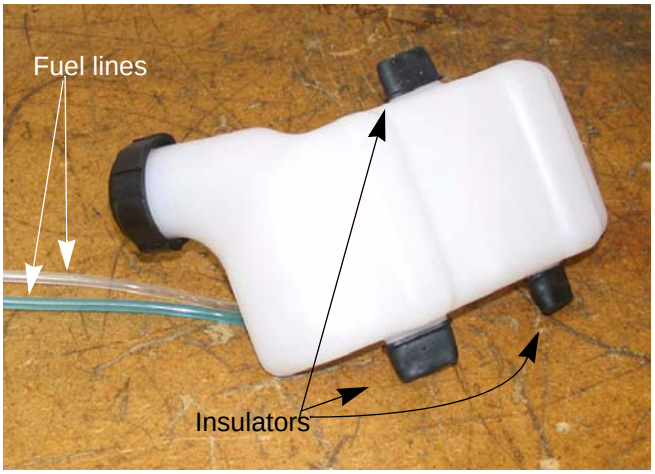

Figure 5.7

Fuel lines

- The carburetor contains a pump that draws fuel through the filter and up the fuel line. A hardened fuel line that has cracked or does not seal tightly to a fitting may draw air into the line without leaking fuel out.
- Air leaks will reduce the fuel pumps ability to supply the carburetor.
- Clear line = fuel supply
- Blue line = return from primer to tank

NOTE: MTD started using low permeation fuel lines on some of the AC3 series of engines in 2009. In 2011, all MTD hand held engines will have the low permeation fuel line to comply with EPA guidelines. The low permeation fuel lines can be identified by their black color.

IMPORTANT: Low permeation fuel lines can NOT be serviced separately. The lower halves of the fuel lines are serviced with the fuel tank and the upper halves comes with the carburetor.

To remove the fuel lines:

1. Disconnect the fuel lines from the carburetor.
2. Pull the blue fuel line out of the tank.
3. Remove the fuel filter by following the steps described in the Chapter 2: Maintenance.
4. Pull the clear line out of the fuel tank.

To install the fuel lines:

1. Cut a point on the new fuel lines.
2. Push the pointed end of the fuel lines into the holes in the tank.
3. Attach the fuel lines to the carburetor.
4. Install the fuel filter following the steps described in the Chapter 2: Maintenance.
5. Test run the engine before placing back into service.

Carburetor

The AC3 series of engines uses the Walbro WYL series carburetors, or a carburetor of similar design from another manufacturer.

The main distinguishing features of this carburetor design are:

- It has a rotary throttle valve, not a butterfly valve.
- A fuel metering needle in the carburetor venturi rises out of an orifice in direct proportion to the movement of the throttle valve.

This design allows fuel to be metered into the venturi in amounts that are directly related to the amount of air allowed to pass through the venturi. The air flow is regulated by the rotary throttle valve.

The Rotary valve resembles a round drum with a hole bored through it. See Figure 5.8.

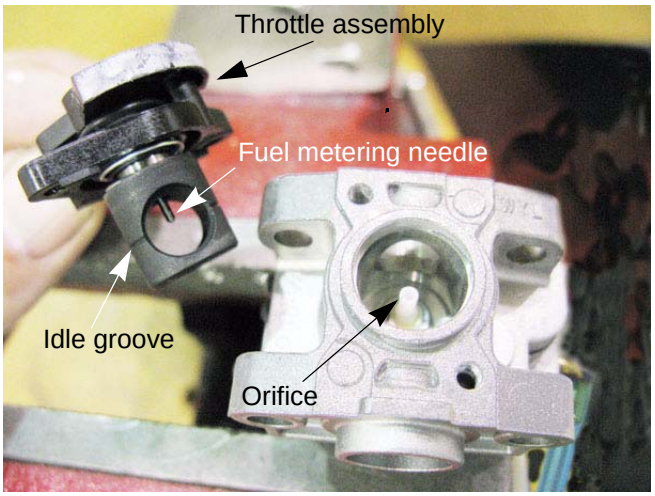

Figure 5.8

- When the hole through the drum is aligned with the throat of the carburetor, the throttle is opened.
- When the drum is rotated so that the hole is not aligned with the throat of the carburetor, the throttle is closed.
- A groove around the drum allows some air to pass-by the drum when the throttle is closed, providing the engine with enough air to idle.

The following picture sequence illustrates the opening of the rotary valve throttle:

1. In the first frame, the throttle is fully closed (idling or stopped). See Figure 5.9.

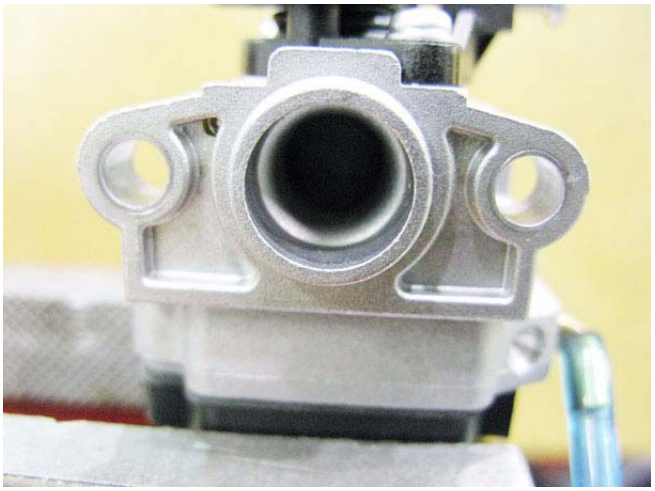

Figure 5.9

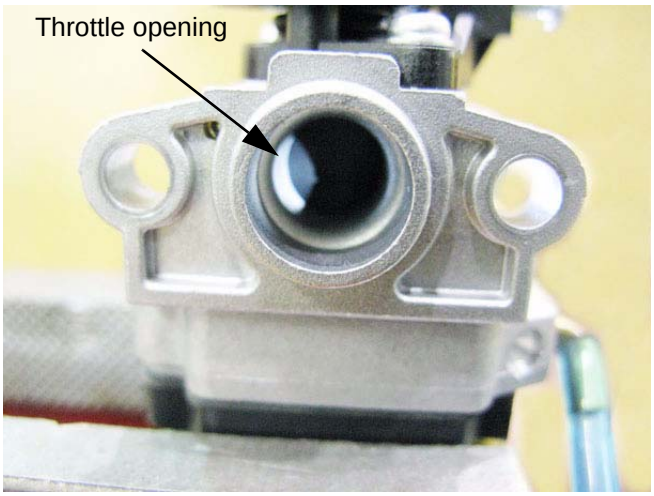

Figure 5.10

2. In the second frame, the throttle has been rotated slightly (tip-in), admitting some air through the rotary valve. See Figure 5.10.

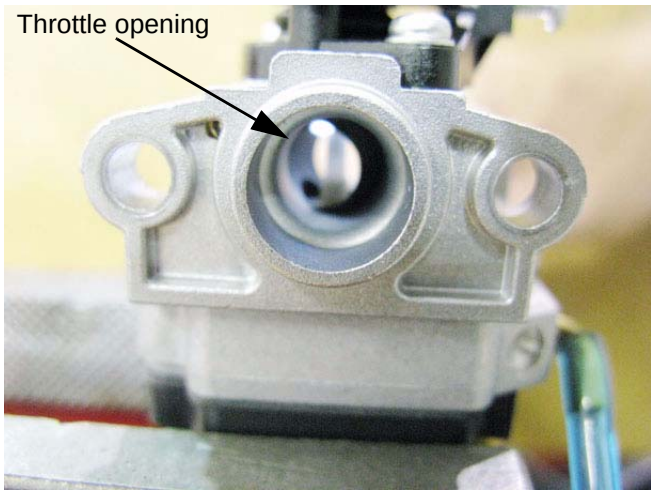

Figure 5.11

3. At mid-range throttle, the throttle is rotated so that the bore is nearly aligned with the throat of the carburetor. See Figure 5.11.

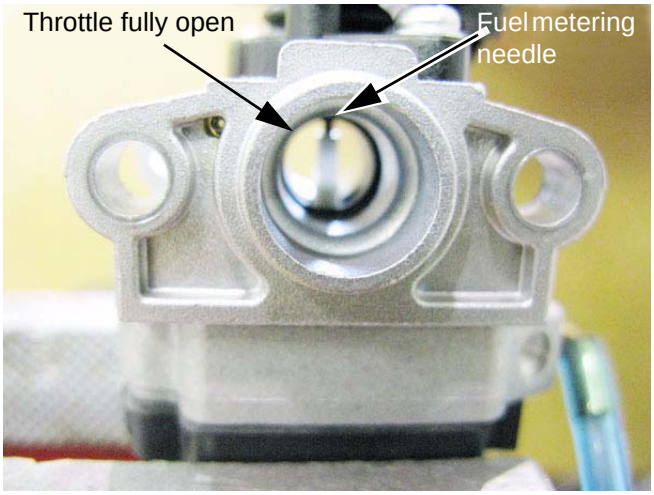

Figure 5.12

4. At wide-open throttle (WOT), the throttle is rotated so that the bore is in-line with the throat of the carburetor. See Figure 5.12.
5. As the throttle opens, it also climbs-up a ramp.

6. In idle position, the throttle is closed, the hole through the drum is cross-wise to the throat of carburetor and the drum is seated at the bottom of its travel. See Figure 5.13.
   - Throttle closed.
   - The top of the throttle arm is 5/16” (7.9mm) above the top of the carburetor housing.

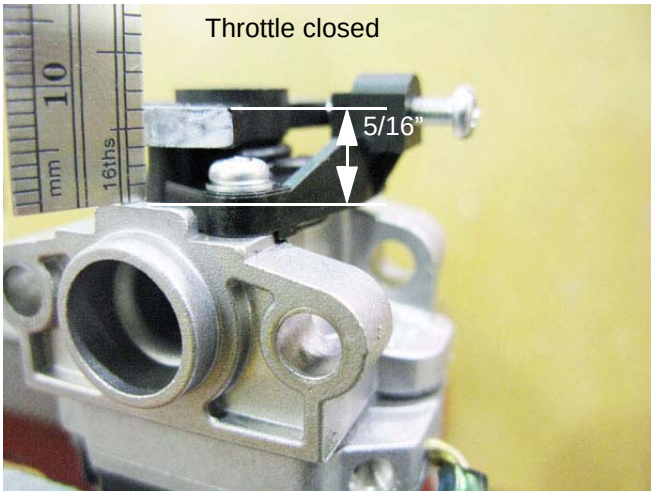

Figure 5.13

7. As the throttle drum rotates, it also climbs-up a ramp. The rising throttle draws the fuel metering needle out of the orifice in the venturi of the carburetor. See Figure 5.14.
   - Throttle at WOT.
   - The top of the throttle arm is 3/8” (9.5mm) above the top of the carburetor housing.

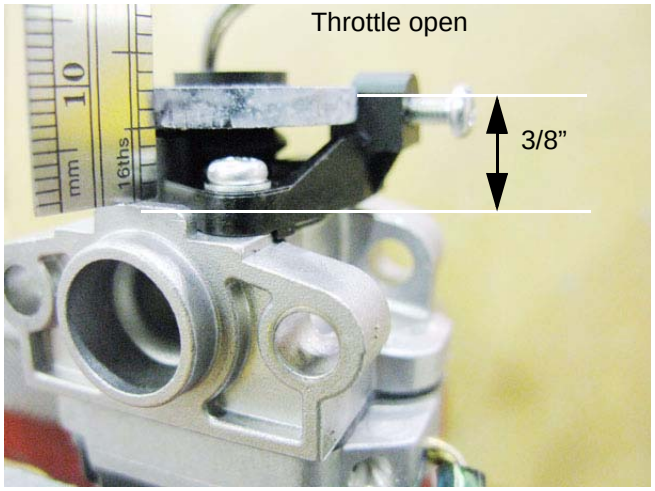

Figure 5.14

Troubleshooting the carburetor

Typically, troubleshooting the carburetor is the last step in the diagnostic process. The other factors are more readily identified; spark vs. no spark, specific pressure readings on a compression gauge, or a visible blockage in the muffler. Carburetor function is more subtle. While specific problems with a carburetor can be identified on tear-down, identification of the carburetor as the location of the problem is usually done by process of elimination.

Treat the carburetor as part of a system. If damaged fuel lines or a blocked filter prevent the carburetor from getting fuel, it will never work right.

Figure 5.15

To troubleshoot the carburetor:

1. Check the operation of the primer. When the bulb is depressed and released, fuel should move through the lines.

NOTE: This is a wet bulb primer. It draws fuel from the fuel tank through the pump and diaphragm chambers and pumps it back into the tank, purging the air from the carburetor. The primer will not squirt fuel into the throat of the carburetor as dry bulb primers do.

2. Remove the air filter cover.
3. Remove the two screws in the air filter housing with a T-25 torx driver. See Figure 5.15.

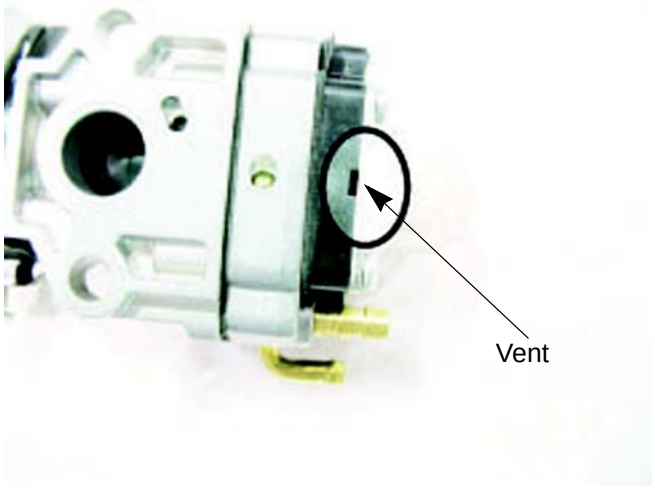

Figure 5.16

4. Disconnect the fuel lines.
5. Disconnect the throttle cable from the carburetor.
6. Inspect and clean the vent under the primer body for debris. See Figure 5.16.

7.If the fuel/air mixture is lean:

- Inspect the carburetor spacer for cracks.
- Inspect the spacer gasket.

NOTE: A cracked spacer or a leaking gasket between the spacer and the cylinder could result in a lean run or prevent the impulses from the engine from driving the fuel pump. See Figure 5.17.

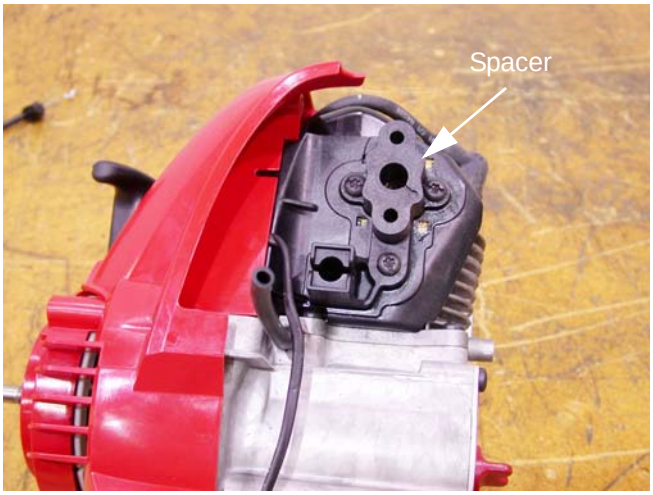

Figure 5.17

8. Inspect the throttle valve assemble for debris and freedom of movement. See Figure 5.18.
9. Perform a needle valve pop off test by following the carburetor manufacturer's recommendations.
10. If there is a problem with the throttle valve assembly, check on availability and price of parts to determine if the carburetor should be repaired or replaced.

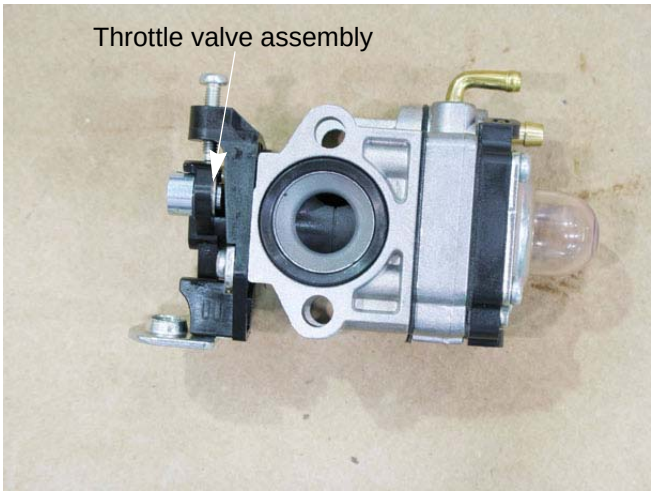

Figure 5.18

Disassembly of the carburetor

Figure 5.19

1. Remove the four screws that hold the carburetor together. See Figure 5.19.
2. Separate the carburetor, placing each part on the bench in the order they came apart.
3. Inspect the diaphragms. If torn, damaged or brittle install a diaphragm kit.
4. Inspect for dirt or varnish build up inside the carburetor. If there is a lot of dirt/varnish in the carburetor, replace it.
5. Check that the needle valve is set to the right height. See the carburetor manufacturer for the proper procedure.

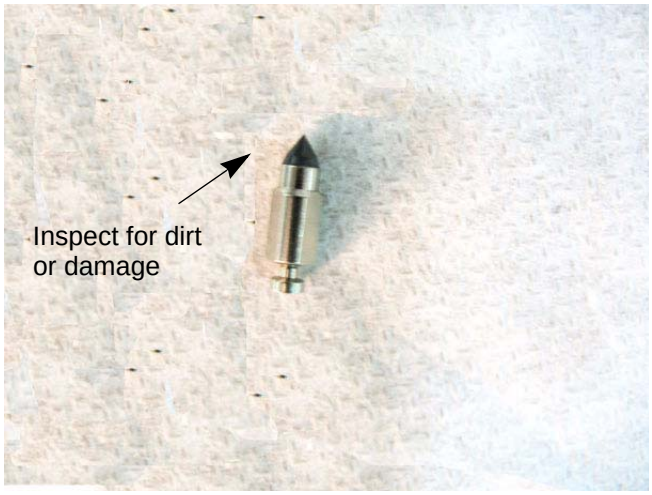

Figure 5.20

6. Inspect the metering valve and the metering valve seat for dirt and/or pitting. See Figure 5.20.
7. If the seat is damaged, replace the carburetor.

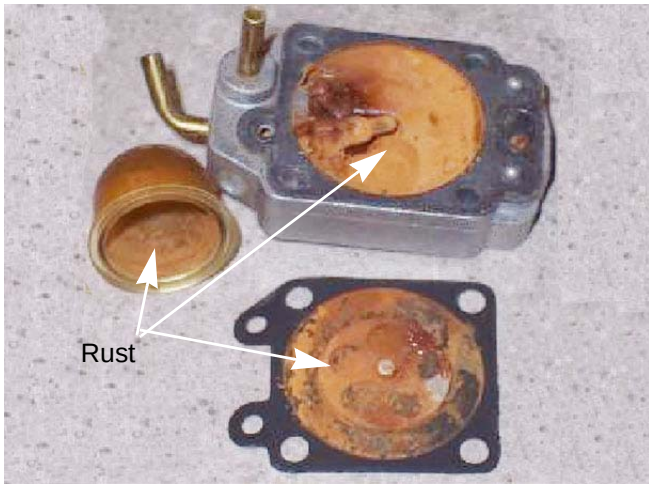

Figure 5.21

NOTE: If there is a minor amount of dirt/varnish in the carburetor, it would be worth while to clean and rebuild the carburetor by following the procedures recommended by the carburetor manufacturer.

NOTE: If there is a lot of dirt/varnish in the carburetor, replace the carburetor.

NOTE: The alcohol in gasoline is hygroscopic, meaning that it readily absorbs moisture. The moisture that is trapped in the alcohol leads to corrosion of metal parts. See Figure 5.21.

8. Remove the throttle valve assembly. See Figure 5.22.

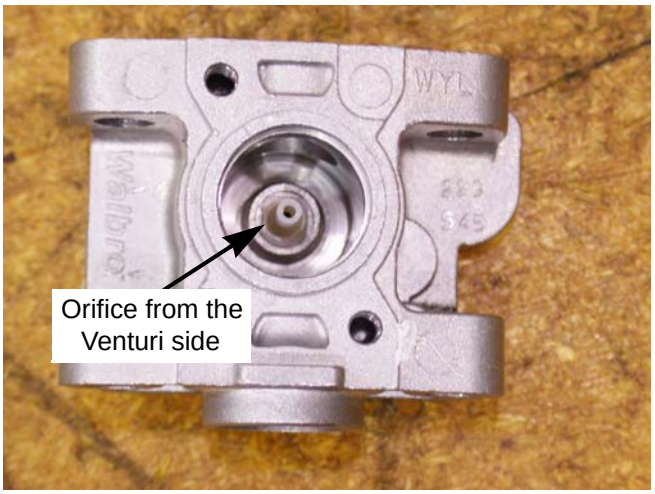

Figure 5.22

9. The orifice can also be seen from the pump side of the throttle housing. See Figure 5.23.

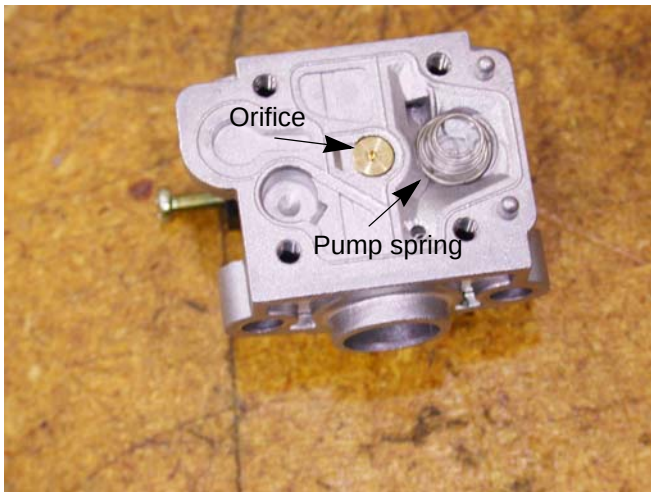

Figure 5.23

10. The fuel pump in the carburetor is driven by vacuum pulses in the intake port. The impulse port from the spacer lets the vacuum pulses into the pump camber. See Figure 5.24.

11. Make sure this port is clean and free of debris.

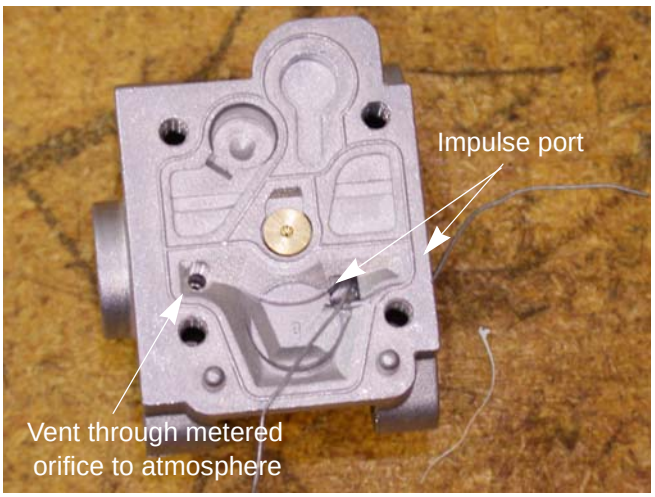

Figure 5.24

Re-assembly of the carburetor

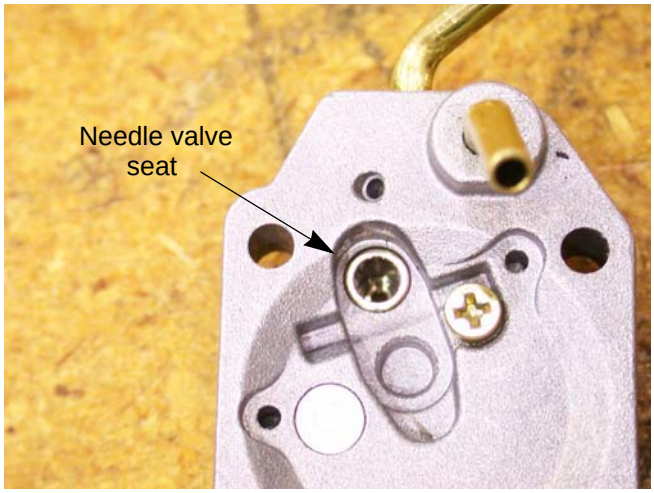

Figure 5.25

1. Place the carburetor in a clean area on the work bench.
2. Inspect the throttle valve assembly for dirt and/or varnish.
3. Install the throttle valve assembly
4. If the needle valve seat is damaged, replace the carburetor. See Figure 5.25.

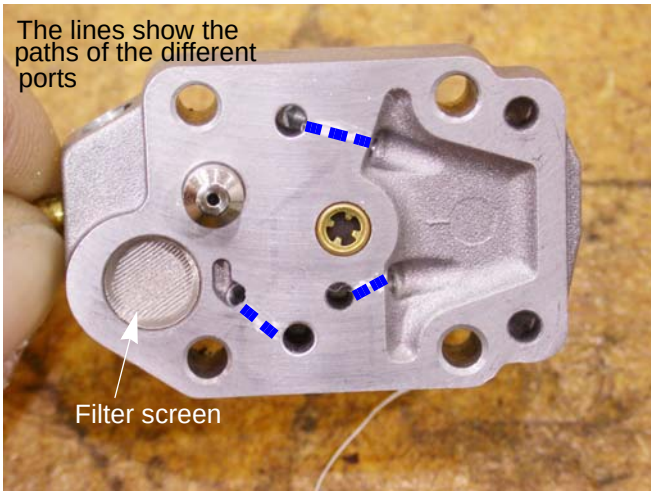

Figure 5.26

5. There are ports in the metering valve body. Inspect them for dirt and/or varnish. See Figure 5.26.

NOTE: The carburetor used in this manual is a Walbro. Depending on the application, the engine may have a different carburetor. All carburetors have a manufacturer name cast on them. It is advisable to contact the carburetor manufacturer for the proper rebuild procedure.

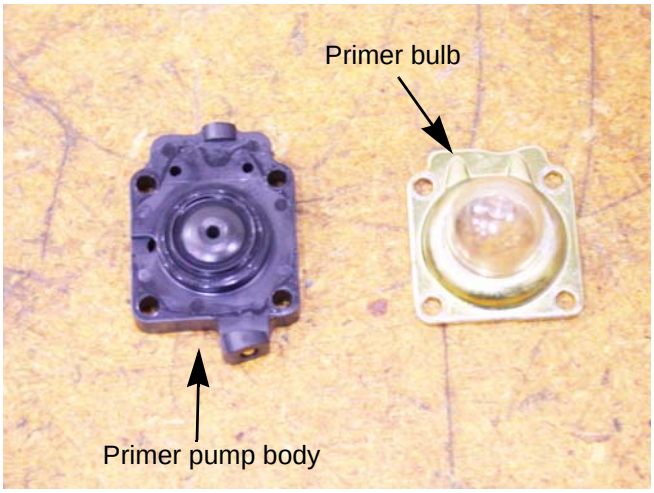

Figure 5.27

6. Inspect the primer pump body for dirt and/or varnish. See Figure 5.27.

7. Clean the metering orifice with carburetor cleaner.

CAUTION Do not insert anything into the orifice to clean it. That will damage the orifice resulting in the carburetor being unrepairable. See Figure 5.28.

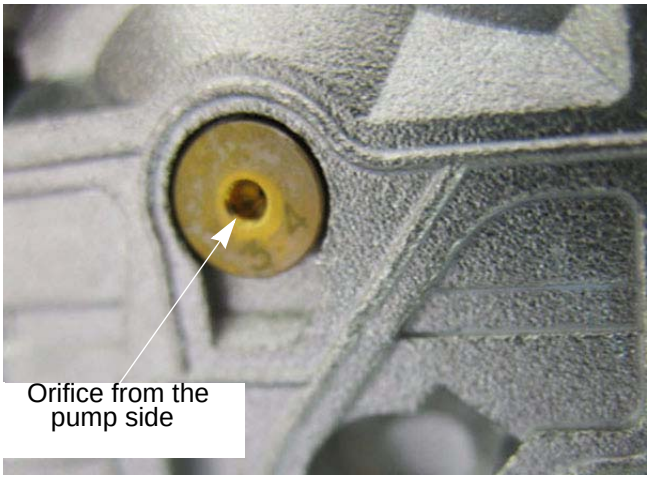

Figure 5.28

8. Set the needle valve lever as per the carburetor manufacturer's recommendations using a W-tool. See Figure 5.29.
9. Follow steps in reverse order to rebuild the carburetor.
10. Perform a needle valve pop off test by following the carburetor manufacturer's recommendations.
11. Install the carburetor on the engine.
12. Test run the engine before returning it to service.

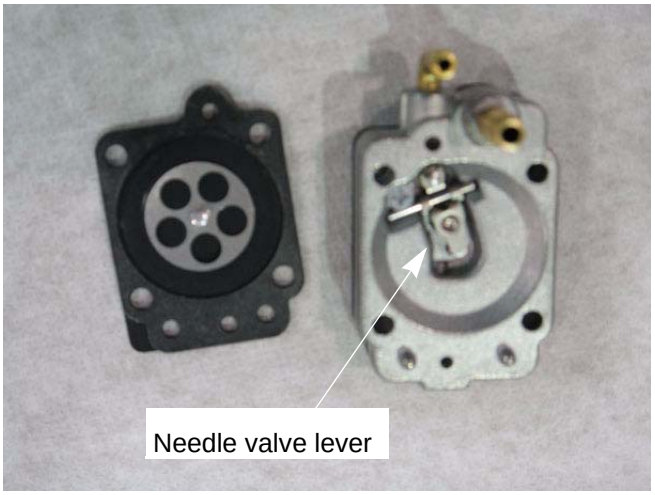

Figure 5.29

Carburetor insulator

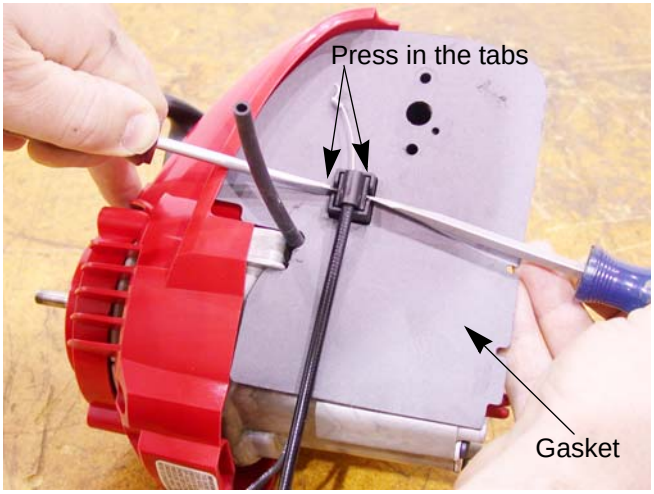

Figure 5.30

NOTE: A cracked spacer or a leaking gasket between the spacer and the cylinder could result in a lean run or prevent the impulses from the engine from driving the fuel pump.

To remove/replace the carburetor insulator:

1. Remove the carburetor by following the procedures described in the carburetor section of this chapter.
2. Remove the throttle cable by pressing in the tabs located in the slots while lifting the cable out. See Figure 5.30.
3. Remove the gasket between the carburetor and the spacer.

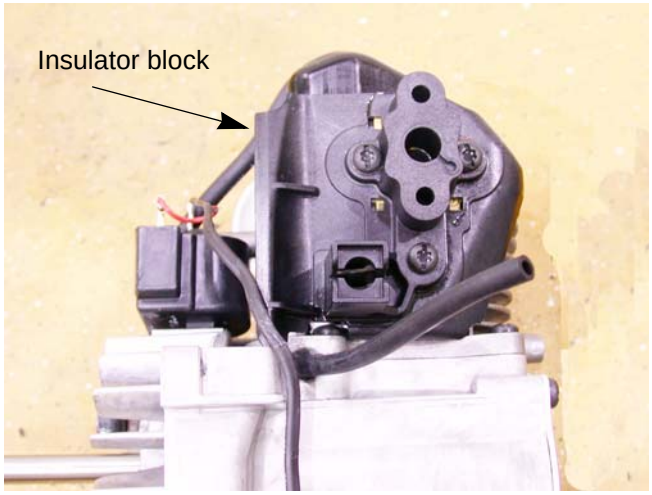

Figure 5.31

4. Remove the carburetor insulator block using a T-25 torx driver. See Figure 5.31.
5. Install the insulator by following the previous steps in reverse order.
6. Test run the engine before returning it to service.

CHAPTER 6: STARTERS

Recoil Starter Removal

Figure 6.1

To remove the starter assembly:

1. Remove the clutch following the steps described in the section on clutch removal.

NOTE: The drive shaft will come off with the clutch housing.

2. Remove the screws that hold the engine cover to the starter housing. See Figure 6.1.

Figure 6.2

3. Remove the four screws in the front of the starter housing. See Figure 6.2.
4. Slide the starter housing off of the engine.
5. Install the starter assembly by following the previous steps in reverse order.
6. Test run the engine before returning it to service.

The starter rope, pulley and springs

The AC3 series of engines are equipped with the Assist Spring Technology (AST) starters.The AST system allows the customer to pull the recoil rope at any pace they please, yet still generate enough force to start the engine.

The system is simple, and adds a grand total of two parts to the trimmer: a recoil pulley assembly, which includes an accumulator spring. As the rope is pulled, the accumulator spring winds-up. When the force on the accumulator spring over-comes the engine compression, it releases it's accumulated energy, spinning the crankshaft rapidly.

To service the rope, pulley and springs:

⚠CAUTION Eye protection should be worn when working on these starters. There are 2 clock springs inside that can come out of the starters at a great velocity.

1. Remove the starter housing assembly by following the procedures described in the previous section of this chapter.
2. Remove the three screws securing the pressure plate to the housing using a T-20 torx driver.
3. If the recoil rope has not already been de-tensioned by breakage, remove the starter handle and relieve tension from the rope.
4. Cut off the starter pulley retaining ring.
5. Carefully remove the pulley and starter assist (accumulator) spring. See Figure 6.4.

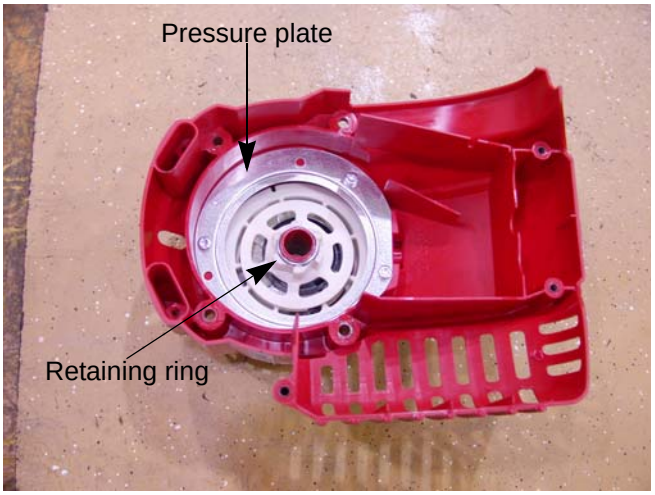

Figure 6.3

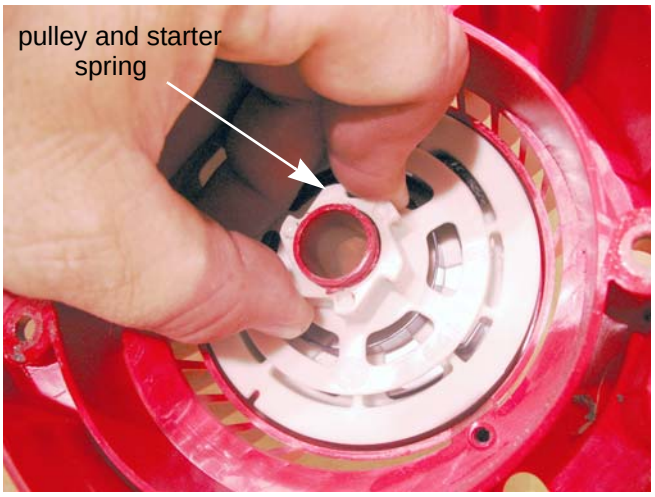

Figure 6.4

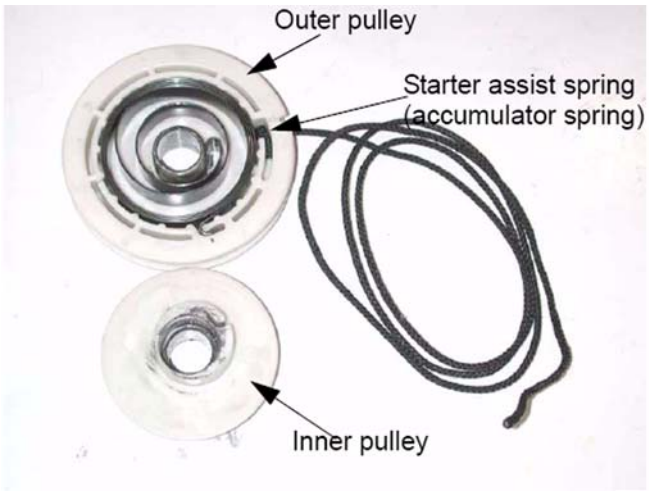

Figure 6.5

NOTE: The recoil pulley assembly consists of three parts, but it is serviced as one assembly. The three parts are: the inner pulley, the starter assist (accumulator) spring, and the outer pulley. See Figure 6.5.

NOTE: When the recoil rope is pulled, it rotates the outer pulley, winding-up the starter assist spring. When the spring accumulates enough force to over-come the compression of the engine, it releases its energy, spinning the inner pulley and the flywheel rapidly. This allows the operator to pull the recoil rope slowly, yet still generate enough cranking speed to start the engine.

Figure 6.6

NOTE: In the starter housing, there is an enclosed recoil spring. If the Starter rope failed to retract, carefully remove the enclosed recoil spring for inspection. Otherwise leave the enclosed spring in place. See Figure 6.6.

To assembly the starter pulley assembly:

1. Install a new starter rope in the recoil pulley assembly.

   1a. Remove the old rope from the pulley.

   1b. Cut a piece of #3 1/2 (7/64”) starter rope 43” (109 cm) long.

   1c. Insert the new piece of rope through the hole in the starter pulley.

   1d. Tie a half hitch knot at the end of the rope.

   1e. Press the knot into the grove in the starter pulley.

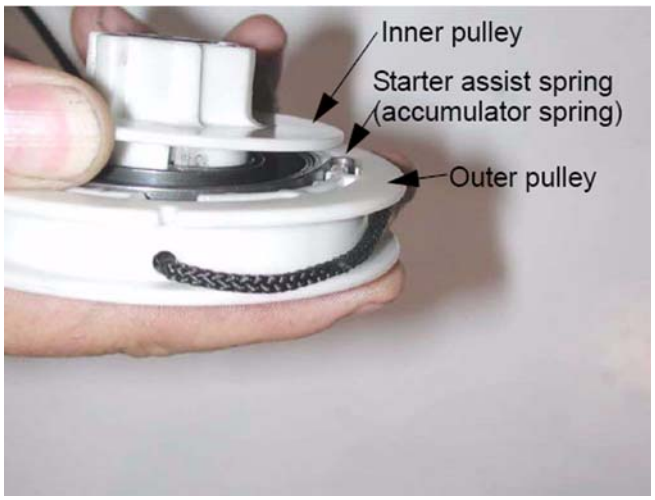

Figure 6.7

2. Lightly lubricate the post that the recoil pulley assembly fits over with a good quality lithium base grease.

Figure 6.8

3. Install the pulley assembly into the starter housing assembly. See Figure 6.9.
4. Install a new retaining ring.
5. Pass the free end of the starter rope through the eyelet in the starter housing.
6. Tie a slip knot in the recoil rope to keep it from getting pulled back through the eyelet.
7. Wind the rope onto the pulley until there is enough tension to consistently draw the recoil handle up against the eyelet.

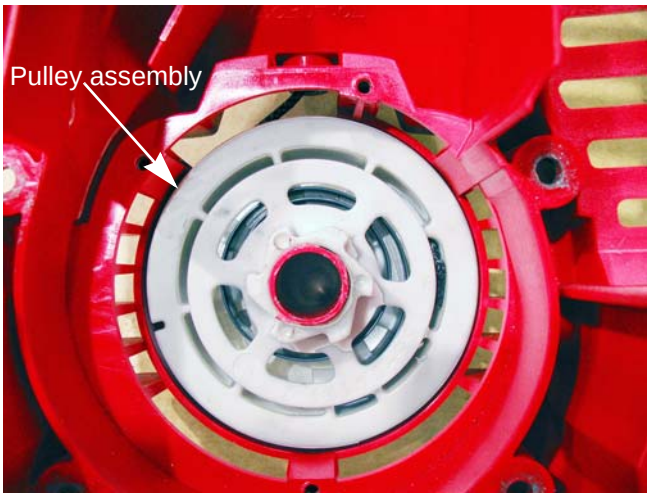

Figure 6.9

Figure 6.10

8. Secure the recoil handle to the rope using two half hitch knots. See Figure 6.10.
9. Release the slip knot.

Figure 6.11

10. Install the pulley retainer using a deep socket to apply even pressure to the retainer while driving it into place. See Figure 6.11.

NOTE: There must be 0.015” to 0.030” (0.38 - 0.76 mm) clearance between the pulley and the retainer. A retainer that is too tight can bind the starter pulley.

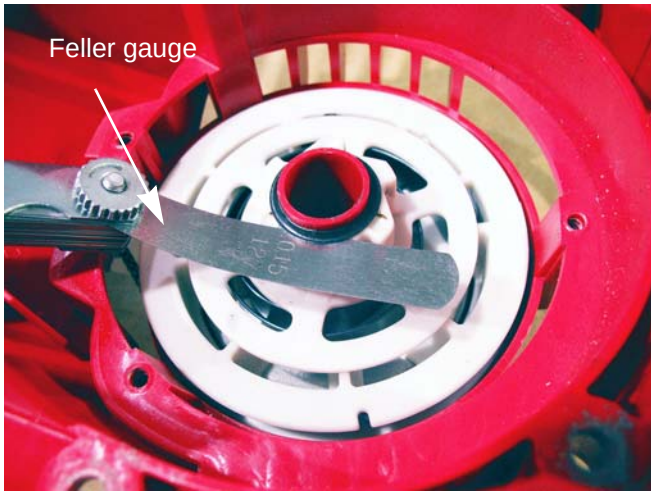

Figure 6.12

11. Check the clearance between the pulley and the retainer using a set of feeler gauges. See Figure 6.12.
12. Install the starter housing assembly be following the procedures described in the previous section of this chapter.
13. Test run the engine before returning it to service.

Electric starter system

For the 2009 model year, MTD introduced an electric start option for some of its hand held engines. The engines equipped with the electric start feature can be identified by the coupler in the sump cover.

There are two types of electric starters available. The first, is a 110V corded electrical motor assembly. To start the engine:

1. Plug the starter motor into a power source.
2. Insert the shaft of the motor assembly into the coupler in the sump of the engine.
3. Push the switch to the “ON” position and the starter will spin the engine at 1,000 RPMs.
4. Once the engine starts, let go of the starter switch and remove the electric starter from the engine.

Figure 6.13

The second type of electric starter is an adapter that fits into an electric drill.

NOTE: The electric drill must spin at 1,000 RPMs of faster.

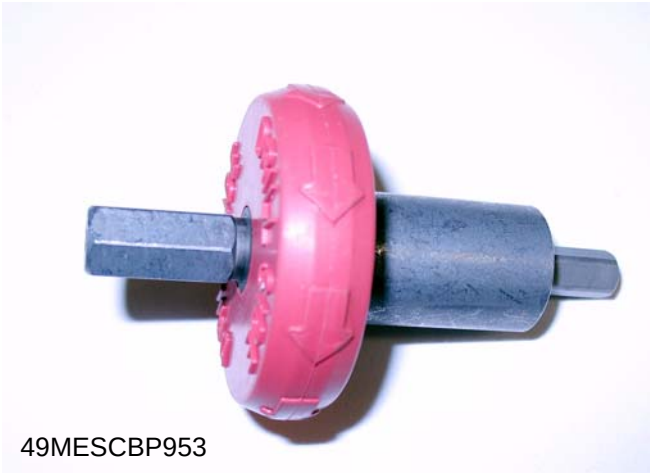

Figure 6.14

The electric starter motor and the adaptor bit are not serviceable. If they fail, they must be replaced.

The coupler in the sump cover is the same for both systems. The coupler is part of the sump cover and is serviced/replaced with the sump cover.

Both starter systems have two things in common:

- A 5-sided (pentagon) drive coupler.
- A one-way clutch so the engine does not drive the electric motor/drill when it starts.

CHAPTER 7: CLUTCH AND UPPER DRIVE SHAFT

Upper drive shaft assembly

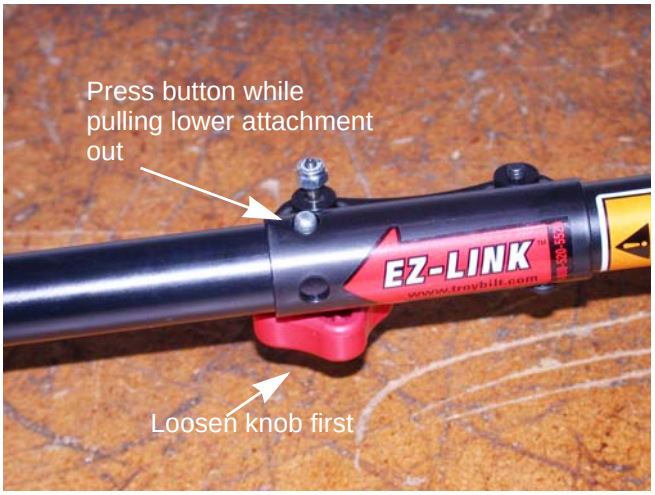

Figure 7.1

The drive shaft assembly consists of the drive shaft housing and a flexible inner drive shaft. The housing and the drive shaft are serviced as one assembly.

To remove the upper drive shaft assembly:

1. Loosen the knob on the ez-link coupling.
2. Press in the metal button while pulling the lower attachment out. See Figure 7.1.

Figure 7.2

3. Inspect the coupling inside the upper drive shaft housing.

NOTE: If the coupling is worn or rounded out, the upper drive shaft housing must be replaced. See Figure 7.2.

4. Remove the six screws in the grip with a T-20 Torx® driver. See Figure 7.3.
5. Let the grip hang off to the side.

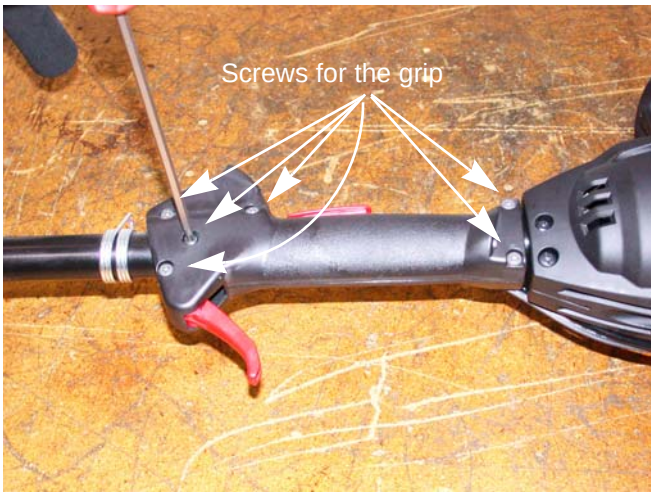

Figure 7.3

NOTE: There are a half dozen parts inside the grip assembly. Be careful that they don't fall out of the grip.

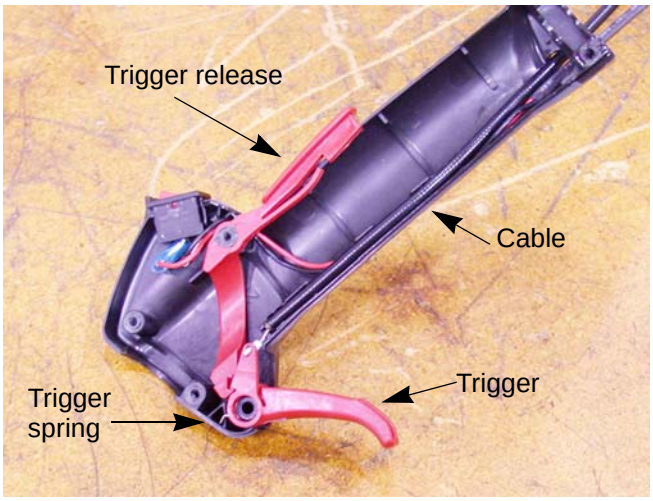

Figure 7.4

6. Remove the anti-rotation screw with a T-20 driver.
7. Loosen the clamping bolt with a T-20 driver. See Figure 7.5.
8. Slide the upper drive shaft housing out of the clutch housing.
9. If replacing the upper drive shaft housing, remove the handle bar.
10. Follow these steps in reverse order to install the upper drive shaft housing.
11. Test run the engine/trimmer before returning it to service.

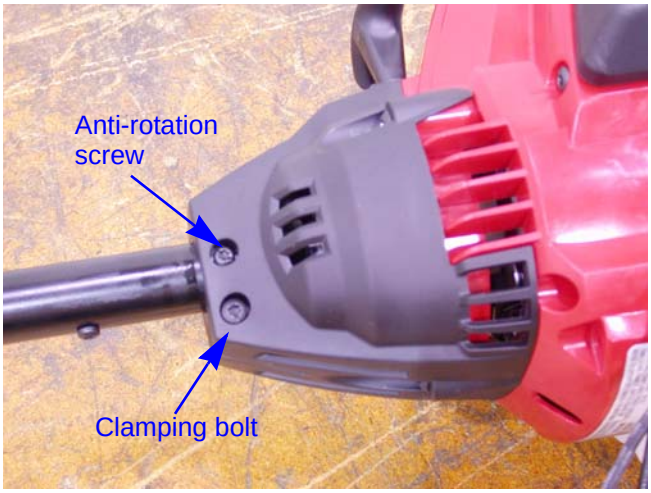

Figure 7.5

Clutch Removal/replacement

Figure 7.6

NOTE: The upper drive shaft may be left connected to the clutch housing. Removing the three screws in the clutch housing will allow the clutch housing and the upper drive shaft to be removed as one.

1. Remove the three screws holding the clutch housing on with a T-20 driver. See Figure 7.6.

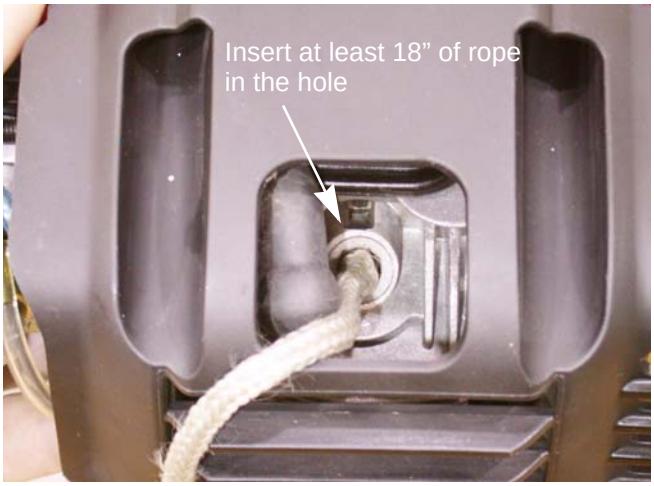

Figure 7.7

2. Disconnect and remove the spark plug.
3. Insert at least 18”(.5 M) of starter rope in the spark plug hole to keep the crank shaft from rotating. Keep some of the rope out so it can be removed later. See Figure 7.7.

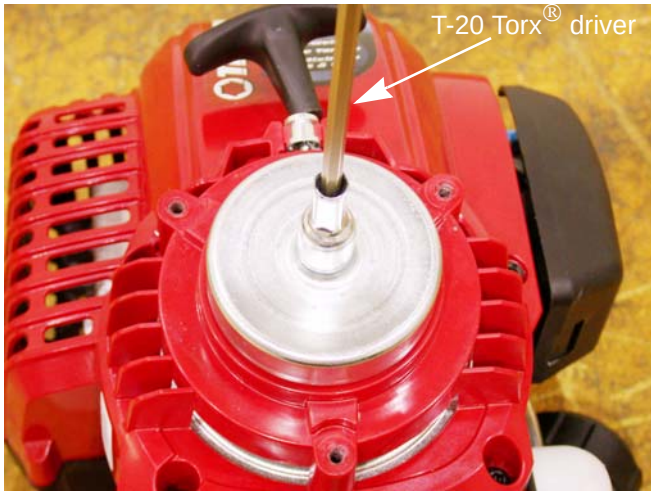

Figure 3.0

4. Remove the clutch drum by removing the screw in the center of it with a T-20 driver. See Figure 3.0.

5. Remove the clutch rotor with a clutch removal tool.

   NOTE: Older engines will have a larger clutch that has roughly a 2 7/16” diameter. They can be removed with part number 791-180918 or the newer clutch tool part number 797-00062. See Figure 7.8.

   NOTE: New engines use a smaller clutch, with roughly a 1 15/16” diameter. They can be removed by using clutch tool number 797-00070.

Figure 7.8

6. Install the clutch rotor.

   NOTE: The big washer goes between the rotor and the starter housing. See Figure 5.0.

Figure 5.0

   NOTE: The lettering on the rotor must face away from the engine. The thrust washer is placed on top of the rotor. See Figure 6.0.

7. Torque the rotor to 100-150 in. lbs.(11.3-16.9 Nm).
8. Slide the clutch drum onto the crankshaft and tighten it to a torque of 38-40 in. lbs.(4.3-4.5 Nm).
9. Install the clutch housing and the upper drive shaft following the steps mentioned earlier in reverse order.
10. Test run the engine/trimmer before returning it to service.

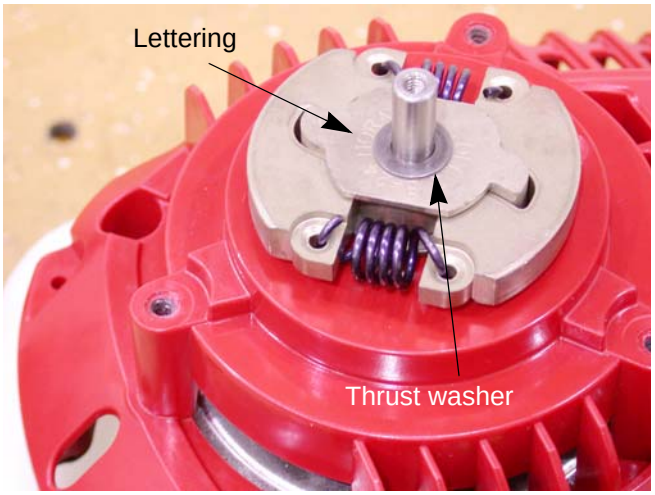

Figure 6.0

CHAPTER 8: ENGINE ASSEMBLY

Economics and parts availability will determine how much engine disassembly is feasible. There are three main levels of engine disassembly.

1. Short block installation.

   Short block installation consists of removing the engine, transferring the external parts to the replacement short block, and installing the engine. External parts consist of:

   - Starter
   - Ignition system
   - Fuel system
   - Muffler

2. Top-end repair

   Some internal parts may be available for service. With minimal disassembly beyond what is involved in a short block replacement, it is possible to replace the cylinder base gasket, piston, piston rings, valve and the cam gear.

3. Complete tear down

   A complete tear down may be done to re-seal the crankcase or for failure analysis. Repair of the “hard parts” such as the bearings, crankshaft or connecting rod is likely to exceed the cost of a short block or a complete engine. Complete tear down information is included in this manual so that technicians can better understand the parts they are likely to come in contact with, such as the PVC system.

   NOTE: The repair/replace choice in warrantable situations must be made using the 2/3 replacement cost rule. Outside of warranty, the decision is left to the dealer and the customer.

Engine disassembly

NOTE: There are a few different paths that can be followed when disassembling an engine. This chapter will cover the removal of components in one order, but it is written so that the technician can go to the component being removed.

1. Drain the oil by following the steps described in Chapter 2: Maintenance.
2. Remove the Clutch by following the procedures described in Chapter 7: Clutch and Drive Shaft.
3. Remove the starter following the steps described in Chapter 6: Starter.
4. Remove the three screws that hold the engine cover to the engine using a T-25 torx driver. See Figure 8.1.

Figure 8.1

5. Remove the three screws that secure the muffler to the cylinder head. See Figure 8.2.

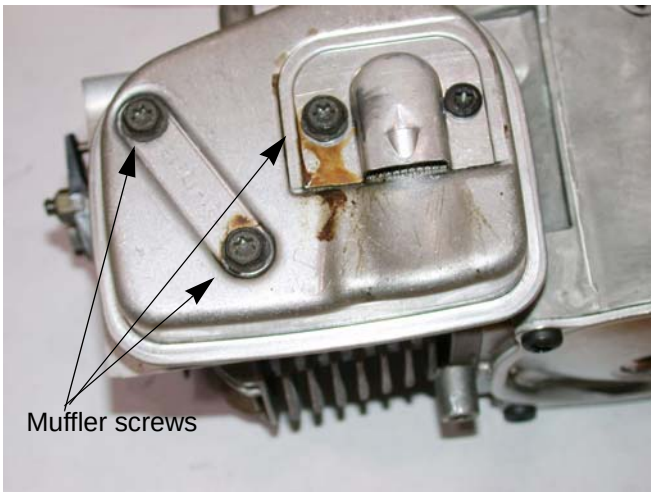

Figure 8.2

6. Remove the air filter cover.
7. Remove the two screws in the air filter housing. See Figure 8.3.

Figure 8.3

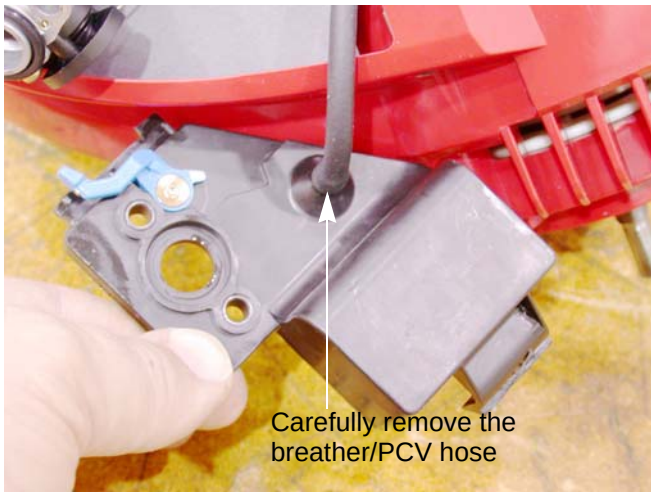

Figure 8.4

8. Carefully disconnect the breather hose from the air filter housing.

Figure 8.5

9. Disconnect the throttle cable. See Figure 8.5.
10. Remove the carburetor, fuel tank and lines as one assembly.

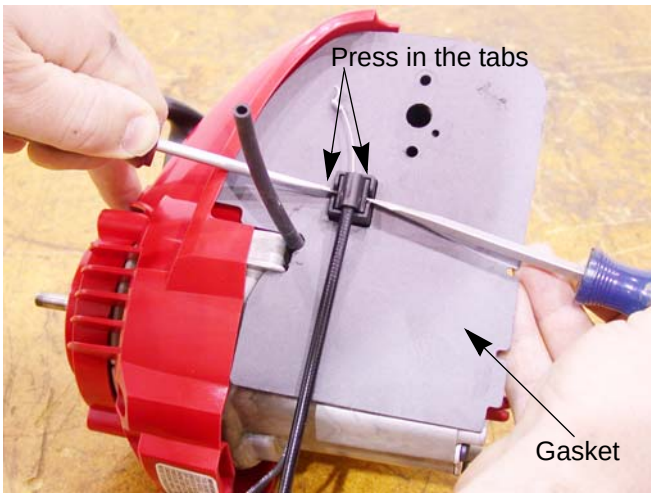

Figure 8.6

11. Remove the throttle cable by pressing in the tabs located in the slots while lifting the cable out. See Figure 8.6.
12. Remove the gasket between the carburetor and the spacer.

13. Remove the carburetor insulator block using a T-25 torx driver. See Figure 8.7.

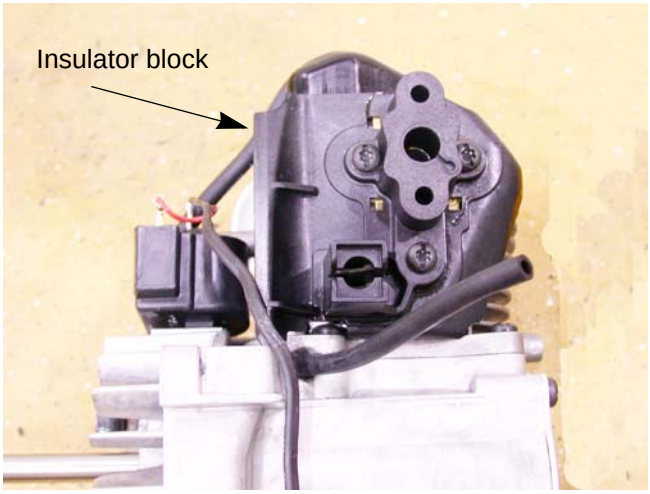

Figure 8.7

14. Rotate the flywheel so that the magnets are away from the module.
15. Remove the two screws that secures the ignition module to the block using a T-25 torx driver. See Figure 8.8.
16. Remove the module.

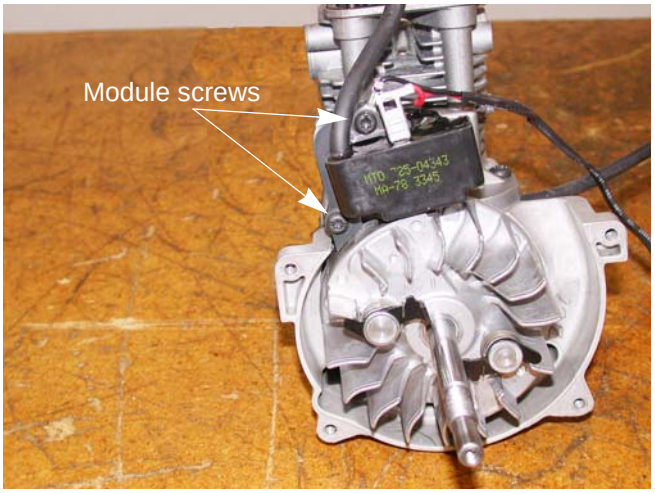

Figure 8.8

17. Remove the flywheel by applying a sharp blow to the crankshaft while gently prying with a pry bar. The flywheel will loosen then lift it off. See Figure 8.9.

CAUTION Never strike the crankshaft directly with a hammer. To prevent damage to the crankshaft use a brass punch or a piece of wood between the hammer and the crankshaft.

NOTE:
If replacing a short block, exchange the crankcase and cylinder with the short block and follow the previous steps in reverse order.

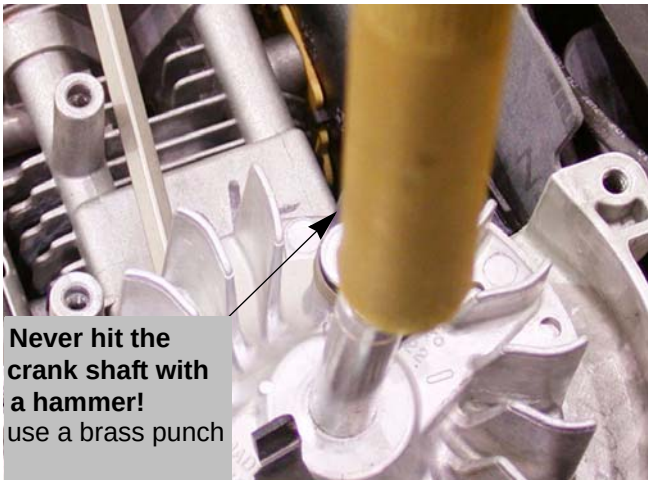

Figure 8.9

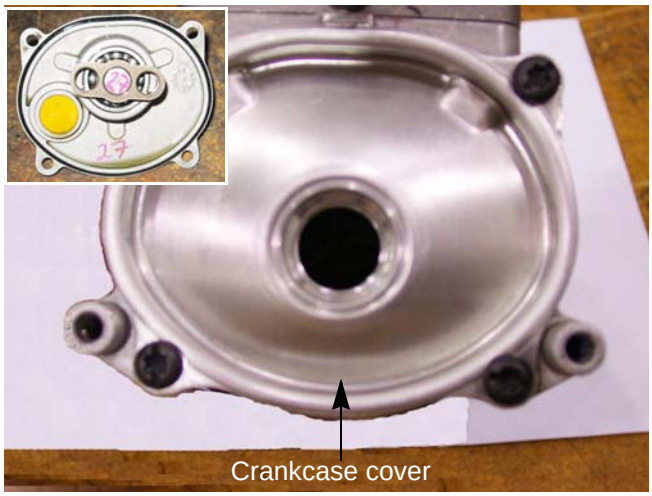

Figure 8.10

IMPORTANT: Check parts price and availability before doing any internal engine repairs.

18. Remove the four screws that secure the crankcase cover to the block using a T-20 torx driver. See Figure 8.10.

NOTE: On engines equipped with the electric start feature, there is a coupler in the sump cover that slides onto the crank pin. See Figure 8.10. inset.

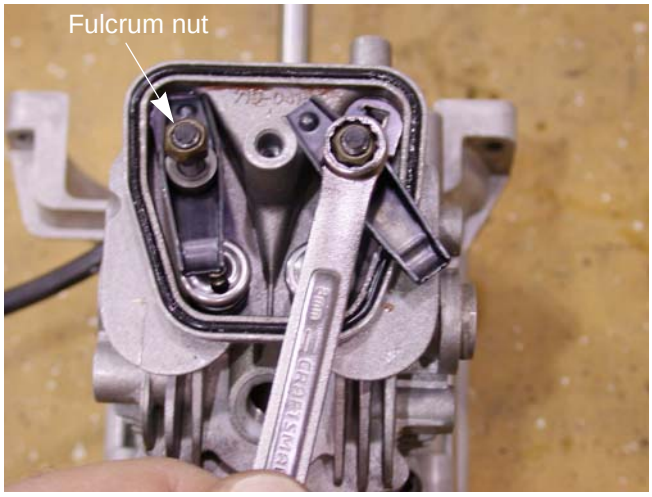

Figure 8.11

19. Remove the valve cover using a T-25 torx driver.
20. Loosen the rocker arm fulcrum nut with an 8mm wrench.
21. Pivot the rocker arms away from the valves and remove the push rods. See Figure 8.11.
22. Remove the 4 screws that fasten the cylinder to the crankcase using a T-25 torx driver.
23. Slide the cylinder off of the piston and connecting rod.

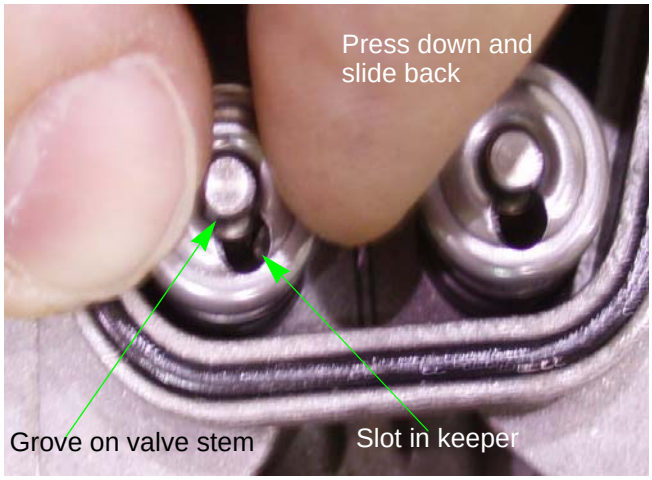

Figure 23.0

24. Press down on the valve keepers and slide the keeper off.
25. Remove the valve springs and keepers.
26. As each valve spring is removed, the valve will fall freely out of the valve guide

NOTE: The valves and valve seats can be cleaned of carbon build-up and inspected. Neither the valves nor the seats can be effectively machined in the field. If a valve is worn or damaged, but the seat is good, replace the valve. If the valve seat is worn or damaged, replace the short block. The cylinder is not available as a service part, and it is not likely to become available at a price that makes cylinder replacement economically feasible.

27. Slide the connecting rod off of the crank pin.

    NOTE: On engines equipped with the electric start feature, the crank pin will be longer so that it can fit into the coupler in the crank case cover. See Figure 8.12.

Figure 8.12

28. Remove the plastic cap from the wrist pin bore of the piston. See Figure 8.13.
29. Withdraw the wrist pin and remove the piston.

    NOTE: If there has been metal transfer from the piston skirt to the cylinder wall, replace the short block.

30. Immediately reinstall the wrist pin in the small end of the connecting rod to prevent damage to the bearing. The wrist pin can be held in place temporarily using a hair pin clip.
31. Carefully remove the piston rings. If they are to be re-used, keep track of the original order and direction of installation.
32. Clean the piston.
33. Carefully clean any gasket and sealant residue from the mating surfaces on the crankcase and cylinder.

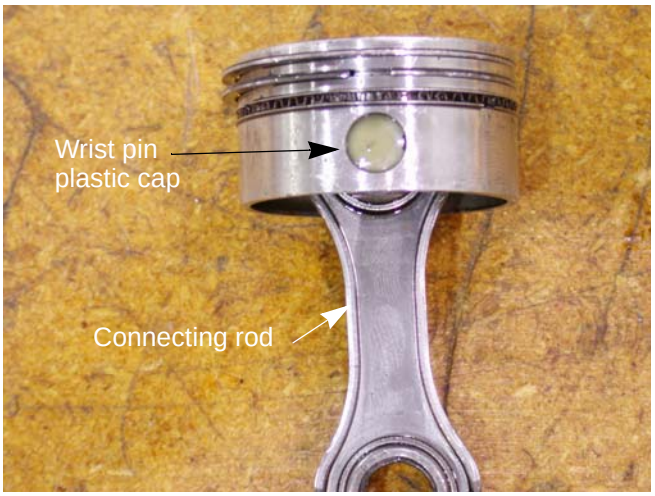

Figure 8.13

34. Remove the cam bracket assembly using a T-20 torx driver. See Figure 8.14.

    IMPORTANT: The crank shaft and cam gear are pressed into the crankcase. Do not try to remove the crankshaft. If the crank shaft needs to be replaced, replace the whole crankcase assembly.

35. Remove the crankcase O-ring and clean the sealing surface.

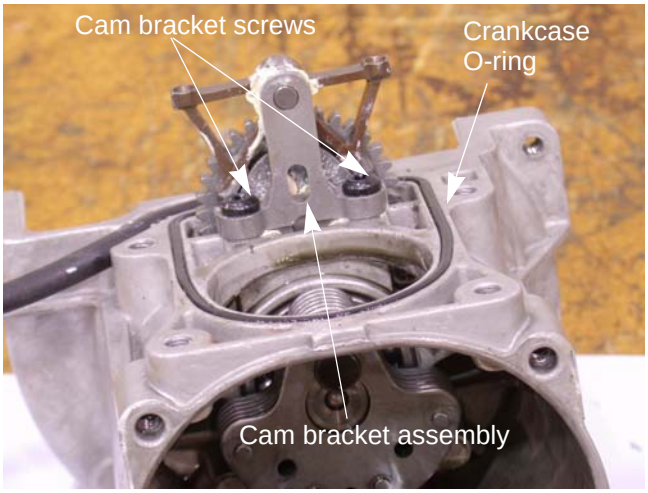

Figure 8.14

Engine Reassembly

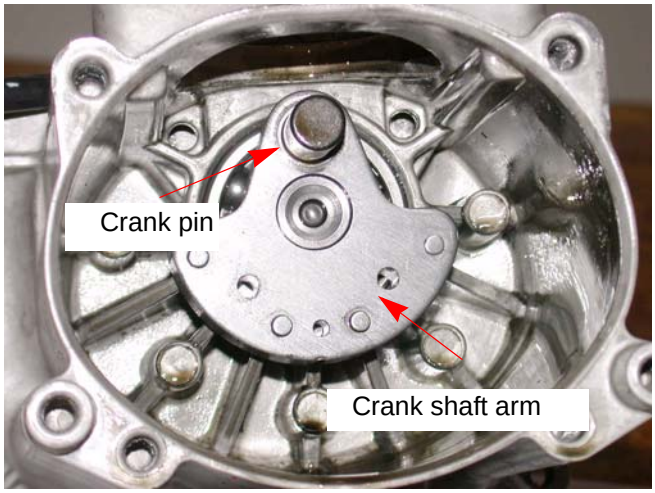

Figure 8.15

1. Rotate the crankshaft to top dead center (crank pin at the top). See Figure 8.15.

NOTE: There are no timing marks on the crankcase.

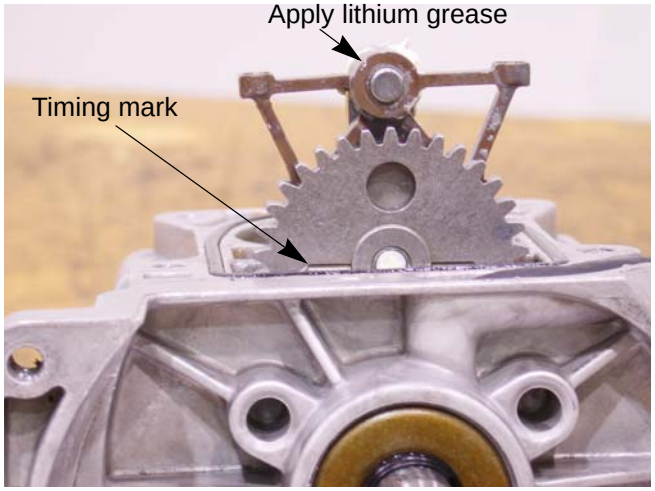

Figure 8.16

2. Install the cam onto the cam bracket.
   - The side of the cam with the hash marks on it faces away from the cam bracket.
   - Lubricate the cam bearing surface with a small amount of lithium grease.
   - Install the cam followers.
   - Apply a dab of lithium grease to the cam follower pivot as a pre-lube.
3. Install the cam bracket assembly aligning the timing mark with the crankcase.

NOTE: The timing marks on the cam gear should be parallel with the top surface of the crankcase. See Figure 8.16.

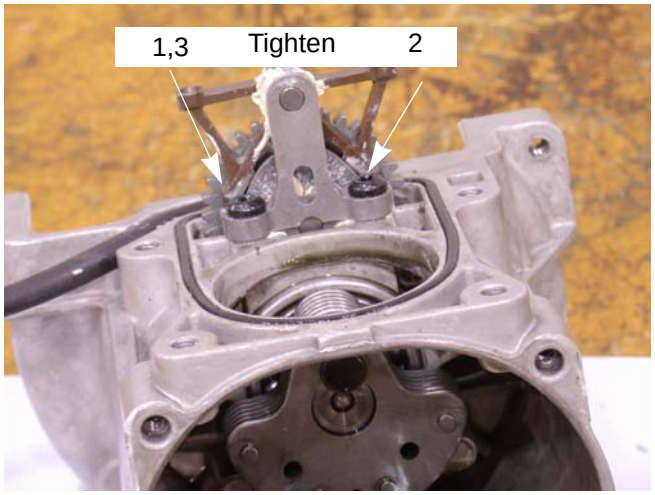

Figure 8.17

4. Apply a thread locking compound such as Loctite 266 to the cam bracket crews. Tighten the screws to a torque of 30 - 35 in lbs (3 - 4 Nm). When torquing the screws, torque the first screw to 15 in lbs. Torque the second screw all the way. Finish torquing the first screw. See Figure 8.17.
5. Insert the valves into the valve guides.

NOTE: Pre-lube each valve stem with a couple drops of 10w30 motor oil to before putting the valve springs on.

6. Install the valve springs and keepers:
   - 6a. Place the spring over the valve stem.
   - 6b. Set the valve keeper on top of the spring.
   - 6c. While holding the valve in place, press down on the keeper with two fingers and slide it into the notch on the valve stem. See Figure 8.18.

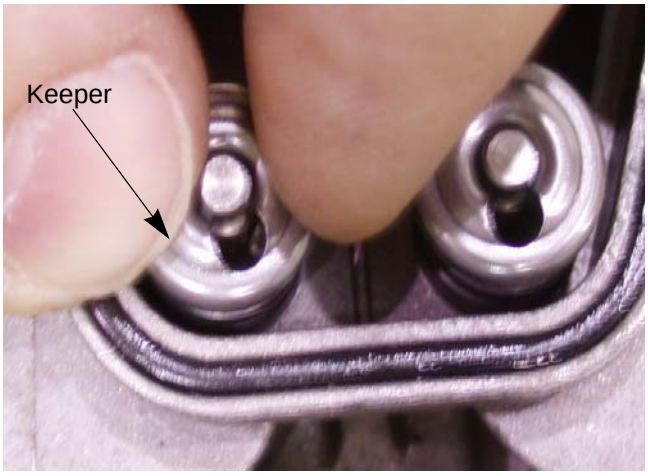

Figure 8.18

7. Install the piston rings on the piston so that the lettering on the rings are facing the top of the piston and the piston ring gaps are 180° away from each other in line with the piston pin.
   - 7a. The top piston ring is convex.
   - 7b. The middle ring is tapered.
   - 7c. The third ring is a 3-piece oil ring.
8. Attach the piston to the connecting rod by inserting the piston pin.

   NOTE: The piston pin will only slide in from one side. After sliding the piston pin in, insert the plastic cap.

Figure 8.19

9. Pre-lube the piston and cylinder wall with 10w30 motor oil.
10. Place the cylinder O-ring on the crankcase.
11. Compress the piston rings and slide the cylinder over the piston just enough to cover the piston rings. See Figure 8.20.

Figure 8.20

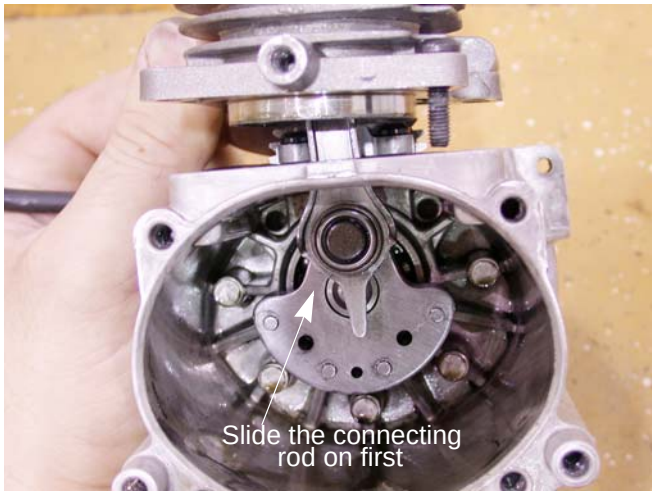

Figure 8.21

12. Rotate the piston so that the lettering on the connecting rod bearing faces the crank shaft journal when installed.

NOTE: Apply a coating of Slick 50® or similar product to the connecting rod bearing as a prelube.

13. Slide the connecting rod onto the crankshaft pin. Align the opening in the cylinder for cam bracket with the cam bracket. See Figure 8.21.

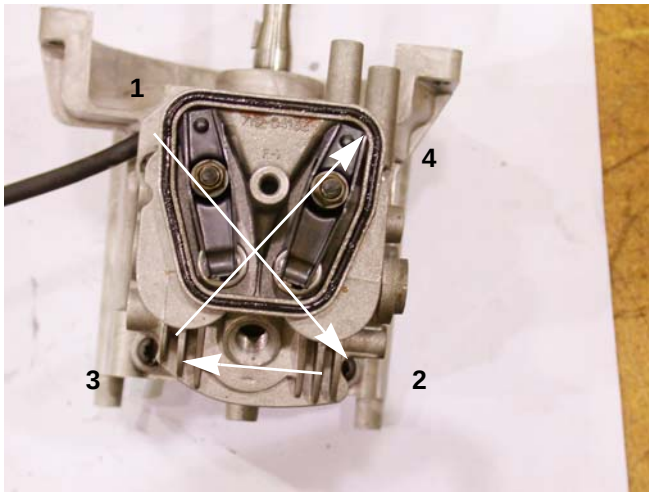

Figure 8.22

14. Apply a thread locking compound such as Loctite 266 to the cylinder head bolts. Install the cylinder head bolts. Torque them to 65-70 in lbs (7 - 8 Nm).

NOTE: Tighten the cylinder head bolts in a “X” pattern. See Figure 8.22.

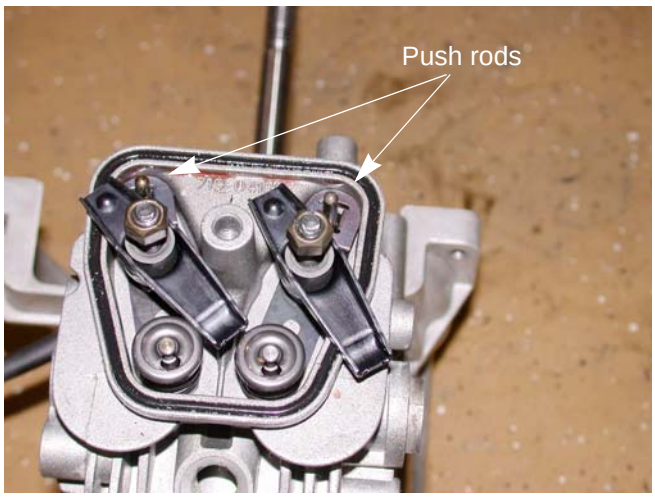

Figure 8.23

15. Pivot the rockers to the side and insert the push rods. See Figure 8.23.

16. Set the valve lash by following the procedure described in Chapter 2: Maintenance.

17. Install the crankcase cover so that the two dimples are toward the cylinder.

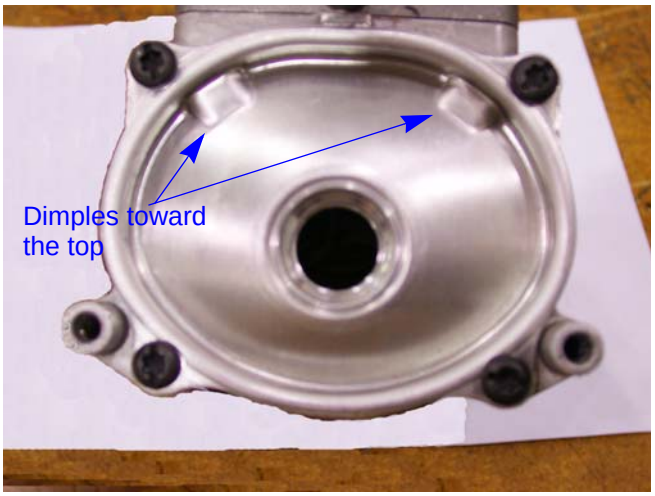

Figure 16.0

NOTE: On engines equipped with the electric start feature, make sure the crank pin slides into one of the holes in the coupler attached to the crank case cover.

18. Install the flywheel and module by following the procedures described in Chapter 4: Ignition.

19. Install the muffler.

NOTE: Apply a thread locking compound such as Loctite 266 to the muffler screws. Tighten the screws to a torque of 50 - 55 in. lbs (20 - 7 Nm).

20. Install the starter by following the procedures described in Chapter 6:Starter.

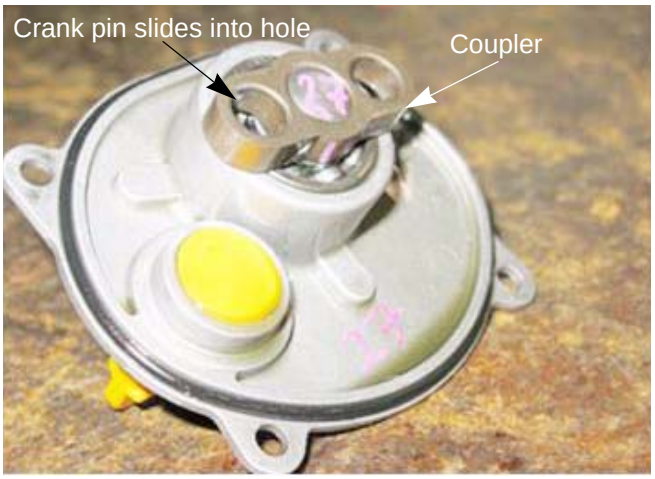

Figure 8.24

21. Install the carburetor spacer, the carburetor and the fuel tank by following the procedures described in Chapter 5: Fuel System and Carburetor.

22. Install the clutch, clutch housing and drive shaft assembly by following the procedures described in Chapter 7: Clutch and Drive Shaft.

23. Install the spark plug.

24. Install the engine cover.

NOTE: Use the machine threaded screws in the casting and the plastic threaded screws in the starter housing. See Figure 8.25.

25. Test run the engine before returning it to service.

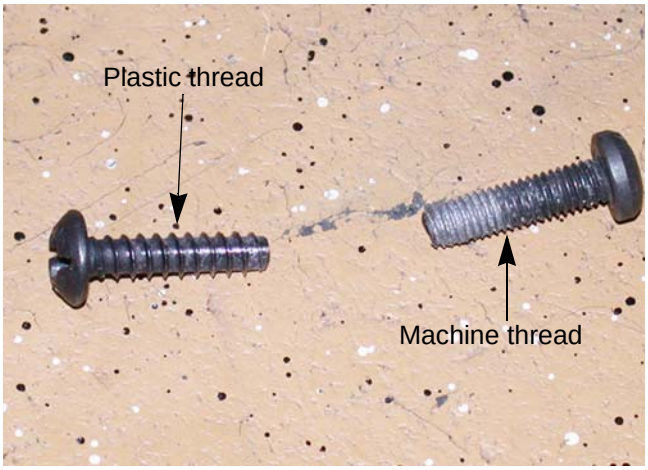

Figure 8.25

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